

**AMERICAN
ENGINEER AND
RAILROAD JOURNAL**

NEW YORK [ETC.]

V.70, Jan.-May, 1896

(ESTABLISHED 1832.)

AMERICAN ENGINEER

CAR BUILDER AND RAILROAD JOURNAL.

M. N. FORNEY,
W. H. MARSHALL, Editors.

R. M. VAN ARSDALE, Proprietor.

Published Monthly at 140 Nassau Street, New York.

INDEX TO VOLUME LXX.—1896.

ILLUSTRATIONS.

Abrasion Testing Machine, The Rieble.....	67	Compound Locomotive, Passenger, Vauclain Type, C. M. & St. P. Ry.....	170	Locomotives, Advantage of Raising the Center of Gravity of.....	63
Abrasion Tests of Iron and Steel, Cambria Iron Co.....	322	Compound Locomotive, 16-Wheeled Freight for Vandalia Line.....	50	Locomotives, Standard of Grand Trunk Ry... 18	
Air and Gas Compressors, The Norwalk.....	177	Compressed Air Ash Hoists at Altoona Shops.....	241	Metal Cars in France, Maintenance and Probable Durability of.....	171
Air-brake Foundation Gear with Independent Hand-brakes.....	292	Compressed Air Riveter for Ship Yards.....	66	Metal Underframes For Freight Cars, Report to M. C. B. Ass'n.....	161
Air-brake Hose, Proposed Marking of.....	199	Compressed Air Sanding Apparatus at Altoona Shops.....	243	Milling Machine for Horizontal and Vertical Milling.....	87
Air-Jack for Raising Driving Boxes, N. Y. C. Rd. 5		Compressors, The Norwalk.....	177	Milling Machine for Locomotive Work, Newton Mach. Tool Wks.....	276
Altoona Shops of the Pennsylvania Railroad, 89, 165, 208, 241, 279, 317		Construction and Maintenance of Railway Car Equipment.....	2, 21, 38, 53, 74, 103, 216, 251, 335	Milling Machine, The Becker Vertical.....	65
Anvil, Spring-supported, for Drop-testing Machines.....	51	Counterbalancing Locomotives, Report to M. M. Ass'n.....	156	Moran Flexible Steam Joint.....	169
Armored Cruiser Brooklyn, U. S. Navy.....	219	Coupling for Transmission Rope, the Hunt.....	87	Motors and Trucks, Lake St. Elev. Ry., Chicago 35	
Axle, Journal Box, Wedge and Bearing for 80,000-lb. cars, report to M. C. B. Ass'n.....	158	Crosshead and Guide, Class L. Engines, Pa. Rd. 281		Naphtba Engine, A New.....	301
Boiler Check Valve, Wright's Safety.....	282	Cruiser Brooklyn, United States Navy.....	219	Oil Purifier, The Q & C Perfection.....	67
Boiler Covering, A New.....	119	Cylinders, A Device for Centering.....	302	Pennsylvania Ave. Subway and Tunnel, Philadelphia.....	95
Boiler for 10-whl. Locomotive, N. Y. C. & St. L. Ry 73		Draft Rigging for 60,000-lbs. Car, C. R. R. of N. J. 81		Piston, Locomotive, of Malleable Iron.....	93
Boiler Locomotive, A Proposed Water-tube... 9		Draft Rigging with Steel Sills.....	320	Piston, Packing, Multiple Tool Post for Turning and Cutting off.....	125
Boiler, The Solignac Mixed.....	22	Drill, Oil Tube.....	277	Pneumatic Tires, Origin of.....	194
Boilers, Locomotive, Effect of Rates of Combustion on the Efficiency of.....	254	Drop-testing Machines, A Spring-Supported Anvil for.....	51	Punching Press, An Improved.....	149
Boilers, Locomotive, with Fire-boxes Lined with Fire-brick.....	36, 82	Dynamometer for Rack End of a Tender.....	110	Rattler for Scrap.....	208
Boilers, The Livet.....	195	Eccentrics, Double, for "Class R" Locomotives, Penna. Rd.....	54	Riveter for Ship Yards, Pneumatic.....	66
Boilers, The Root, at the National Electrical Exposition.....	201	Electric Motor, The Gibbs Portable.....	65	Rock Island Bridge, Operating Mechanism for Sand Mixing Machine, Centrifugal.....	47
Boilers, Water-tube, Experiments on Heating Value of Tubes of.....	235	Electric Motors, Why They Revolve.....	285	Saw, Improved Cutting-off.....	15
Boring Machine, Double Cylinder.....	237	Engine, A New Naphtba.....	301	Slide Valves, Reports to M. M. Ass'n.....	155
Brake Beam, A New.....	61	Engine Board, N. & W. Ry.....	302	Slotting Driving Boxes, Attachment for.....	5
Brake Shoe Keys, Q. & C. Pressed Steel.....	353	Exhaust Pipes and Smokestacks for Locomotives, The Most Advantageous Dimensions for.....	11, 21, 45, 83, 132, 190, 231, 270, 311	Smokestack Base Dies, P. & R. Rd.....	5
Bridge, Timber Economical Designing of.....	62	Exhaust Pipes and Steam Passages, Report to M. M. Ass'n.....	153	Smokestack, cast-iron, C. & N. W. Ry.....	116
Cableways, Lidgerwood, at Hawaiian Islands; Car, Box, of 60,000 lbs. Capacity, with Steel Sills, C. B. & Q. R. R.....	44	Fire-boxes with Fire-brick Walls.....	36, 82	Smokestacks and Exhaust Pipes for Locomotives, The Most Advantageous Dimensions for.....	11, 27, 45, 83, 132, 190, 231, 270, 311
Car, Coal, Truss for Sides of.....	55	Fireproofing Tests.....	228	Special Shop Tools.....	5
Car, Furniture, C. M. & St. P. Ry.....	208	Fuel, Powdered, Wegener's Apparatus for.....	138	Speed Control of Modern Steamers.....	187
Car, Freight, Campbell's Combination.....	6	Governor, High-speed Belt, for Corliss Eng. 26		Spray Ejector for Urinals, The Niagara.....	148
Cars, Freight, Metal Underframes for.....	161	Governor, The Brownell Automatic.....	31	Stay bolt, Expansion.....	167
Car Door, The Q & C Hoyt Flush.....	150	Graphical Method of Keeping Accounts.....	101	Staybolt, Flexible.....	208
Car Heating, Gold's Improved Jet System of Hot Water Circulation for.....	31	Grate for Burning Fine Anthracite.....	313	Steam Passages and Exhaust Pipes, Report to M. M. Ass'n.....	153
Car, Hopper Gondola, of 60,000 lbs. capacity, Cent. Rd. of N. J.....	80	Grinder, Tool, The Pickerman.....	67	Steam Pipe Joints for Locomotives, Report to M. M. Ass'n.....	199
Cars, Metal, in France, Maintenance and Probable Durability of.....	171	Guide and Crosshead for Class L. Eng., P. Rd. 281		Steam Trap, The Diamond.....	32
Car, Passenger, with Wide Vestibules, L. S. & M. S. Ry.....	52	Indicator Diagrams, Effect of Long Pipes on.....	112	Steps and Handholds on Locomotives.....	157
Car, Steel Flat, Carrying 40 tons.....	285	Indicator Rigging for Locomotives.....	118, 206	Tank with Sloping Sides, C. B. & Q. R. R.....	56
Car, The Fader Dump.....	238	Jacking Steam Chests and Cylinder Heads.....	64	Tender Water Scoop, Balanced.....	283
Car Truck, The Schoen Pressed Steel.....	66	Journal Box for 80,000 lbs. Cars, Report to M. C. B. Ass'n.....	158	Tires, Pneumatic, Origin of.....	194
Car, Twin-Hopper Gondola of 70,000 lbs. capacity, Nor. Pac. Rd.....	35	Key-Seater, The Lake Portable.....	16	Tires, Wear of, on New York Central Passenger Engines for Past 20 Years.....	51
Chilled Cast Iron Tools.....	241, 310	Lathe, the Wagner 12-inch.....	238	Tool Post, Multiple, for Turning and Cutting off Piston Packing.....	115
Coal and Ash Handling Plant, C. C. C. & St. L. Ry.....	287	Link Motion for 10-wheeled Locomotive, N. Y. C. & St. L. Ry.....	73	Tools of Chilled Cast Iron.....	241, 310
Coal, Powdered, Wegener's Apparatus for.....	132	Locomotive, Class L. Penna. Rd.....	167, 280	Trap, The Diamond Steam.....	32
Coaling Station at Wabash, C. C. C. & St. L. Ry 70		Locomotive Fire-boxes with Fire-brick Walls.....	36, 82	Trestles, Timber, Economical Designing of.....	62
Combustion, Effect of Rates of, on Efficiency of Boilers.....	254	Locomotive for Burning Crude Petroleum.....	268	Truck for 46 ft. Furniture Car, C. M. & St. P. 210	
Compound Locomotive for L. S. & I. Ry.....	211	Locomotive for 8 per cent. Grade.....	321	Truck for Passenger Car, The Brill.....	193
Compound Locomotives, Mogul, on Penna. Rd. 243, 279		Locomotive, Heavy Express, C. & N. W. Ry... 4		Truck, The Schoen Pressed Steel.....	66
Compound Locomotive, Noiseless Switching, N. Y. C. & H. R. R.	76	Locomotive, Heavy Express, Big Four.....	4	Trucks and Motors, Lake St. Elev. Ry., Chicago 35	
		Locomotive, Mogul Freight for Maine Central 218		Tubes, Piecing out.....	205
		Locomotive, Mogul Freight, N. Y., N. H. & H. 267		Turbine, 300 H. P. Laval Performance of.....	245
		Locomotive, Passenger, Great Western Ry..... 39		Valves, Slide, Report to M. M. Ass'n.....	155
		Locomotives, Pass. and Freight for B. & O..... 289		Vise and Winch Combined, The Doherty.....	148
		Locomotives, Recent Baldwin.....	339	Vise, A Spring, P. & R. Rd.....	5
		Locomotive, Ten-Wheeled, N. Y. C. & St. L. 72		Vise for Shapers.....	87
		Locomotive, Ten Wheel Passenger, Erie Rd. 309		Water Gage Glasses, Protection of.....	56

Water Scoop, Balanced, for Loco. Tenders.....	283
Wheels, Instructions for Mounting.....	163
Wrench, The Star Pipe.....	150

NOTES AND NEWS.

Air-brake Suit, Westinghouse vs. Boyden.....	1
Air-brake Pipes, Bending of by Compressed Air.....	42
Air in Steam Cylinders, Use of.....	331
Air, Liquid, Manufacture of.....	305
Alcohol in the Manufactures and Arts.....	301
Alumtum Bronzes, Rule for Casting in.....	171
Armor, Government Plant for Making.....	33
Annual Report of Illinois Steel Co.....	49
Arbitration Committee, A Decision of.....	12
Acetylene, Use of in Gas Engines.....	262
Axle, Crack, A Form of Built-up.....	110
Battle Ship Indiana, Performance of at Sea.....	304
Black Diamond Express on Lehigh Valley Rd.....	110
Boilers, Belleville, Tests of.....	79
Boilers, Belleville Water-tube on the North-corn Line Steamers.....	305
Boilers, Compound Marine.....	262
Boiler Explosion, Locomotive, on Del., Sus. & Schuylkill Rd.....	49
Boiler Steel, Proposed Amendment of Government Specifications for.....	42
Boilers, Water-tube, Automatic Feed for.....	225
Boring Tires, Economy in.....	61
Brake, The Sweeney.....	111
Branch Pipes, Use of Malleable Iron for.....	111
Bridge, East River, Approval of Plans of.....	363
Bridge Erection, A Remarkable Record in.....	49
Bridge, The East River, Estimated Cost of.....	262
Bridge over the Delaware at Philadelphia.....	49
Buildings, Lofty, Stability of.....	110
Cabs Wanted on English Engines.....	145
Calson at Brooklyn Navy Yard, Failure of.....	226
Calorimetry Practice, Rules for.....	263
Canal, Chicago Main Drainage.....	17
Canal, North Sea-Baltic.....	17
Canals, of New York State, Business of.....	1
Carriage, Horseless, Race in France.....	303
Carriage, Horseless, The Cosmopolitan Races.....	33
Carriage, Horseless, Prizes for.....	184
Car, a Globular.....	362
Car Building in the D., L. & W. Shops.....	111
Car Heating, Putting Apparatus on Sleepers in Control of Train Crew.....	33
Car, Ruth Combined Parlor and Sleeping.....	61
Car, Sleeping for Great Northern Railway.....	32
Cars Exported from United States in 1895.....	69
Cars, Freight, Heated for Winter Use.....	33
Cars, Increasing the Average Loading of.....	110
Cars, Passenger, A Fatal Fire in.....	1
Cars, Passenger, for the West Coast Route.....	1
Charters, Railroad, As Contracts.....	33
Coal and Coke Fuel, Relative Cost of.....	262
Coal Consumption of a Revolver-Corliss Engine.....	61
Coal from China on Pacific Coast.....	303
Coal, Need of Determining the Heating Value of the Volatile Portion of.....	79
Coal Premiums in England, Trouble with.....	17
Coal Unloading Machine, the Long.....	53
Coasting Barge, A New Type of.....	224
Compound Locomotive Tests on the Penn. Rd.....	224
Compressed Air, for Whitewashing and Painting.....	262
Compressed Air, Reported Use of, at Pullman.....	69
Counterbalancing Locomotives, Bill for an Appropriation for Experiments on.....	1
Cruisers for Japan.....	323
Depth of Water in the Pacific, The Greatest.....	69
Diamonds Formed from the Carbon in Steel.....	224
Discipline on Lehigh Valley Railroad.....	1
Draught, Howden Forced, Contracts for.....	69
Drills, Electric.....	110
Electric Cars, Power Required to Operate.....	115
Electric Cars, Proposed Lunch or Dining.....	1
Electric Drills.....	110
Electric Lamps for Train Conductors.....	42
Electric Locomotives at Marks Colliery, Pas-de-Calais, France.....	17
Electric Locomotive, The Baldwin-Westinghouse, on the Turtle Creek Valley Branch of the P. R.R.....	33
Electric Mine Locomotive, Baldwin-Westinghouse.....	49
Electric Motive Power on the New Haven Road, Proposed Extension of.....	262

Electric Motors for Brooklyn Bridge.....	17, 33, 62
Electric Railroad between Baltimore and Washington, Beginning the Construction of.....	69
Electric Road for Northern Michigan.....	224
Electric Power Transmission from Lachise Rapids, St. Lawrence River.....	111
Electric Suburban Roads as Feeders to Steam Roads.....	69
Electric Traction, Views of Mr. F. W. Webb.....	69
Electric Traveling Crane vs. Steam Crane.....	303
Elevators, High Pressure, Failure of.....	331
Engine, Compound, of Light Weight.....	42
Engine, Quadruple-Expansion Marine.....	61
Engines, Comparison of Thermal Efficiencies of.....	111
Engineers in the British Navy.....	184
Engines, New, for the Germanic.....	225
Engines, Pumping, for Philadelphia.....	61
Engines, Itenold-Corliss, Coal Consumption.....	61
Engines, Triple Expansion, Performance of.....	304
Fast Run on a German Road.....	224
Feed, Automatic, for Water-Tube Boilers.....	225
Ferryboats for Brooklyn & New York Ferry Co.....	42
Ferryboats, twin-screw, for Penn. Rd.....	80
Ferryboat, Twin-Screw, Launch of.....	303
Fly-Wheels, Wire Wound.....	17
Forest Area of the United States.....	61
Fuel, Oil, on Great Eastern Ry. (England).....	42
Gas Engine Using Producer Gas.....	116
Gas Engines in Germany.....	262
Gas Engines, Use of Acetylene in.....	262
Gas Engines, Use on Lightships.....	184
Gears, Advantages of Short Teeth for.....	224
Gold, A Proposed Substitute for.....	1
Graphite Used for Lubricating Rails on Curves.....	55
Hammer, Steam, The Bethlehem.....	20
Head-linings, Metal, for Passenger Cars.....	61
Horse-power for 1½ lbs. of Coal.....	224
Hospital for Employees of A. T. & S. F. Ry.....	33
Ice Palace at Truckee.....	1
Iron and Steel Works in Japan.....	216
Iron Gates of the Danube Removed.....	303
Iron Ore, Output of in Lake Superior Region.....	17
Iron, Pig, Imported into England from Ala.....	111
Iron, Production of Pig in 1895 in the U. S.....	1
Lake Levels, Influence of Ice in the Rivers on.....	114
Land Slide in Himalaya Mountains.....	112
Liverpool Overhead Electric Ry., Extension of.....	69
Loading of Cars, Increasing the Average of.....	110
Locomotive Building, Number of Men in Great Britain Employed in.....	42
Locomotive, New Australian.....	226
Locomotive, New Passenger on C. R. I. & P. Ry., Fast Run of.....	181
Locomotive, The Holman.....	221
Locomotives, With Wooden Fire-Boxes, Only One Man on the Lookout.....	17
Long Coal Unloading Machine.....	53
Longest Regular Run Without Stops, The.....	303
Lubricants, Experiments With in Prussia.....	229
Lubricants, Method of Testing.....	226
Motor Carriage Races, The Cosmopolitan.....	33
Mount Yamulpa's Scenic Railway.....	1
Narrow Gauge Railways in France.....	17
Northern Pacific Receivership.....	1
Northwestern Elevated Rd. of Chicago, Prog.....	49
Oil Fuel on Great Eastern Ry. (England).....	42
Oxidizing Bright Work of Steel, Rule for.....	111
Painting Handrails, Casings, etc., of Loco.....	33
Paints for Iron Work, Different Pigments in.....	79
Patent Law, Amendment of Mexican.....	301
Pipe Coverings, Test of.....	42
Premiums for Making up Lost Time on French Railways, Awarding of.....	17
Pullman Cars Displaced by Wagner.....	145
Pumping Engines for Philadelphia.....	61
Rack Railways, Number of.....	61
Radiation from Steam Pipes, Loss of Heat by.....	83
Railroad Terminal Expenses.....	224
Railroads Unjustly Treated by the Daily Press.....	145
Rails, Lubrication of, On Curves.....	55
Railway Construction in India, New Terms.....	145
Railway Construction in Japan.....	69
Railway Construction in Norway.....	225
Railway in Peru, A concession for.....	49
Railways of Argentine Republic.....	181
Retarders in Tubes of Boilers, Effect of.....	225
Riveting, Cold, Pressure Required.....	69
Rivets, Best Angle of Countersunk Heads for.....	69
Savage Gun for New York State Militia.....	293
Ship-Building on the Pacific Coast.....	225

Ship-Building, Progress of the Leading Nations.....	112
Shops, New for Boston & Maine Rd.....	111
Shops, New for Concord & Montreal Rd.....	49
Shops, Proposed New, for Southern Pacific Rd.....	49
Sluicing in the Cascade Mountains.....	69
Staying Fireboxes, A New Method of.....	224
Steam Calorimeter, Rules for Use of.....	263
Steam Hammer, The Large Bethlehem.....	20
Steam Pipes in Smoke Boxes, Use of Malleable Iron for.....	111
Steamer, The Largest on the Great Lakes.....	49
Steamships for the North German Lloyd.....	181
Steamship Records on the Atlantic.....	171
Steel, Microscopic Study of.....	17
Stoking, Automatic Underfed.....	42
Superheated Steam.....	262
Technical Club of Chicago.....	69
Telescope for Chicago University.....	304
Test Pieces, Elongation Affected by Length.....	226
Tires, Economy in Boring.....	61
Tires, Locomotive, on the Great Eastern Ry.....	69
Torpedo Boat Destroyer <i>Desperate</i> , Speed of.....	69
Torpedo Boat, Launch of a.....	303
Torpedo, Trial of the New Howell.....	304
Track Elevation at Newark, N. J.....	81
Train Loads, Heavy Average on Beech Creek.....	17
Train Wrecks on Norfolk & Western Rd.....	1
Trains, New, on the East Coast Route.....	225
Trucks, Four-Wheeled, for All Express Passenger Cars on West Coast Route.....	1
Tunnel, Simpson, Signing of Agreement for Construction of.....	17
Turbine, Laval Steam, Performance of.....	110
Underfed Stoking.....	42
Water Stations, Railway, Use of Large Delivery Pipes at.....	50
Wire-Wound Flywheels.....	17
Wrecks on Norfolk & Western.....	1
Yacht, Steam, for C. R. Flint.....	304
Yacht, Steam, for P. A. B. Widener.....	42

EDITORIAL.

Air-Brake Men, Convention of the Ass'n of.....	78
Air-Brake Pumps vs. Compressors.....	106
Air-Brake Suit, Westinghouse vs. Boyden.....	10
Air Compressor, An Absurd Design of.....	220
Announcement of Consolidation of the American Engineer and Railroad Journal and the National Car and Locomotive Builder.....	8
Anvil, Spring Supported, For Drop Testing Machines.....	58
Apprentice Boy, The.....	113
Baker, Geo. H.....	40
Boiler, Steel, Specifications for.....	5
Boilers, with Fireboxes Lined with Firebrick.....	40
Bridges, Timber Trestle, Economical Design of.....	58
Buffer Blocks and M. C. R. Car Couplers.....	259
Business, Honesty and Patriotism.....	258
Car Coupler Decision, Gould Coupler Co. vs. Pratt & Letchworth.....	142
Car Couplers, Automatic, and Buffer Blocks.....	259
Carriage, Horseless, in London.....	294
Car, Standard, Movement to Establish.....	332
Cars, Steel Underframes for.....	182
Cast-Iron Wheels, Thermal Tests of.....	107, 221, 299
Cast Iron vs. Steel-tired Wheels.....	332
Clippings, Filing by Photography.....	291
Compressed Air in Railroad Shops.....	220
Compressor, an Absurd Design of.....	221
Compressors vs. Brake Pumps for Shop Use.....	116
Counter Balancing Locomotives.....	141
Cruiser <i>Brooklyn</i> , The.....	239
Detentions of Passenger Trains.....	8
Driving Wheels, Large vs. Small.....	221
Drop Testing Machines, Spring Supported Anvil for.....	58
Economy in Shop Work.....	40
Electrical Exhibition in New York.....	21
Electricity, Application of to Steam Roads.....	106
Electricity on Steam Roads, Prospects for.....	301, 334
Elevated Railroads and the Brooklyn Bridge.....	78
Employes' Duty to Employers.....	294
Engineers in Our Navy, Breakdown of.....	221
Engineers in the Navy, their Status.....	295
Engineers in the Navy, The Wilson-Squire Bill to Improve the Status of.....	78
Feed Water, Pure.....	182
Fireboxes Lined with Fire Brick.....	40
Friction, Reducing Journal Box.....	8
Gas Engines, Advantages of.....	182

62505

AE
V. 70

REMOTE STORAGE

Grates, Locomotive.....	78	Apprentice Boy, Discussion Before M. M. Ass'n.....	131	Cast-iron vs. Steel-tired Wheels.....	309
Grates, Locomotive, Large vs. Small.....	24	Arbitration Committee, Rulings of.....	311	Cast-iron Wheels in Europe.....	124
Heating Buildings by Heat from the Hot Well.....	182	Arches, Experiments on.....	37	Cast-iron Wheels, Mileage in Freight Service.....	215
Indicator Diagrams, Effect of Long Pipes on.....	106	Ass'n Supt. Bridges and Bldgs.....	351	Cast-iron Wheels, Thermal Tests of.....	206, 246
"Industry".....	41	Atchison, Topeka & Santa Fe, Sale of.....	10	Central Railroad Club.....	9, 269
Interchange, Adoption of the New Rules of.....	142	Axle, Journal Box, Wedge and Bearing for 80,000-lb. Cars, Report to M. C. B. Ass'n.....	158	Chemistry Applied to Railroads.....	51, 101, 212
Interchange at St. Louis, Problems Arising from Damage Due to Cyclone.....	182	Baltimore & Ohio Tunnel Plant.....	285	Chilled Cast-iron Tools.....	211, 310
Interchange, Committee for Revising Rules of Interchange, The Revised Rules of.....	24	Bates Thermic Engine, The.....	285	China, Situation in.....	351
Journal Box Friction, Reducing.....	8	Battleships, The Contracts for the New.....	269	Citizenship and Technical Education.....	341
Lead, Reduced, for Locomotives.....	143	Boiler Check Valve, Wright's Safety.....	282	Chinese Railway Projects.....	54
Locomotive, A New English.....	40	Boiler, Combined Safety, Water-Tube, Test of.....	141	Coal and Ash Plant, C. C. & St. L. Ry.....	287
Locomotive Grates.....	78	Boiler Covering, A New.....	149	Coal, Powdered, Wegener's Apparatus for.....	138
Locomotive Grates, Large vs. Small.....	24	Boiler Jackets, Locomotive.....	269	Coal, Spontaneous Ignition of.....	269
Locomotives, Defects and Improvements in.....	222, 260, 333	Boiler for Ten-Wheeled Locomotive, N. Y. C. & St. L. Ry.....	73	Combustion, Effect of Rates of on Efficiency of Boilers.....	254
Mail, Railway, Decision on.....	220	Boiler, Locomotive, A Proposed Water-Tube.....	9	Commercial Travelers' Fair.....	315
Master Car Builders' and Master Mechanics' Conventions.....	114	Boiler Plant for the Nat. Elec. Exposition.....	124	Compound Locomotive for L. S. & I. Ry.....	211
Master Car Builders' Convention, Topical Discussions at.....	142	Boiler Practice, European.....	307	Compound Locomotive for Northern Pacific Ry.....	331
Master Mechanics' Association, Convention for 1896.....	58	Boilers, Belleville, Evaporative Trials of.....	14	Compound Locomotives, Mogul, on P. Rd.....	243, 279
Metric System, Compulsory Adoption of.....	58	Boilers, Locomotive, Effect of High Rates of Combustion on Efficiency of.....	251	Compound Locomotive, Noiseless Switching, N. Y. C. & H. R. R.....	76
Navy, Our Crippled.....	295	Boilers, Locomotive, with boxes lined with brick.....	36, 82	Compound Locomotive, Passenger, Vandalia type, C. M. & St. P. Ry.....	170
Patent Office, Abuses in the.....	40	Boilers, Radial Stay vs. Crownbar, Discus- sion before M. M. Ass'n.....	131	Compound Locomotive, Ten-wheeled Freight for Vandalia Line.....	50
Patent, The Value of a.....	109	Boilers, The Livet.....	15	Compressed Air Ash Hoists at Altoona Shops.....	241
Piston Rods, Extended.....	58	Boilers, the Root.....	145	Compressed Air Loco, on the Manhattan Rd.....	265
Pooling Locomotives, Abandonment of the System on the P. C. C. & St. L. Ry.....	40	Boilers, The Root at the Nat. Elec. Exposition.....	201	Compressed Air Machinery on Monitor Terror.....	346
Pooling of Locomotives.....	142	Boilers, Water-Tube, Experiments on Heat- ing Value of Tubes.....	235	Compressed Air Riveter for Ship Yards.....	66
Power Required to Drive Jack-Shafts.....	221	Boilers, Water-Tube, in the British Navy.....	39	Compressed Air Sanding App. at Altoona.....	243
Rules of Interchange, Revising.....	24	Boilers, Water-Tube, On French War-Ships.....	286	Compressed Air Transmission of North Star Mining Co., Grass Valley, Cal.....	189
Rules of Interchange, The Revised.....	41	Boilers, Water-Tube, The Hoberts.....	353	Compressed Air, in A., T. & S. F. Shops.....	66
Screw-Threads, International Standard for.....	69	Boilers, Water-tube, Tests of.....	195	Compressed Air, Use in Shops.....	330
Second-Class Railroad Traffic in England.....	78	Boiler, The Solignac Mixed.....	22	Compressors, The Norwalk.....	177
Shafting, Power Required to Drive.....	221	Boiler Tubes, M. M. Ass'n, Standard Sizes of.....	157	Construction and Maintenance of Railway Car Equipment.....	2, 21, 38, 53, 74, 103, 216, 251, 335
Slide Valves, Europeans Ignorant of Ameri- can Practice Regarding.....	259	Boring Machines, Double Cylinder.....	67	Copper and Iron Conductors.....	275
Smoke Abatement, Its Relation to Economy.....	143	Brake Beam, A New.....	24	Copper, An Extended Use of.....	7
Spitting in Cars.....	24	Brake Shoes, Laboratory Tests of, Synopsis of Report to M. C. B. Ass'n.....	129	Counterbalancing Locomotives, Report and Discussion before the M. M. Ass'n.....	130, 156
Stationary Plants on Railroads.....	224	Brake Shoe Keys, Q. & C. Pressed Steel.....	333	Coupling for Transmission Rope, The Hunt.....	87
Steel Boiler, Specifications for.....	58	Bridge at Detroit, Proposed Michigan Central Bridges, Experiments on Arches of.....	74	Crosby Steam Gage & Valve Co.....	141
Steel Underframes for Cars.....	182	Bridges, Timber, Economical Designing of.....	62	Croshead & Guide, Class L Eng., P. Rd.....	281
Titles of Journals Appropriated.....	42	Bulkhead Door for Steamships.....	119	Crosheads, Laird.....	34
Timber Tests, Importance of Continuing.....	79	Cable Company, The Pacific.....	9	Cruiser Brooklyn, United States Navy.....	219
Tobacco Nuisance, The.....	60	Cables, Cappings for.....	305	Cylinder Bushings, Discussion, M. M. Ass'n.....	131
Tobacco, Tolerance of.....	169	Cableways, Lidgerwood, at Hawaiian Islands.....	27	Cylinder Bushings, Report to M. M. Ass'n.....	157
Train Detection, Passenger.....	8	Cableways, The Lidgerwood.....	67	Cylinders, A Device for Centering.....	302
Trestles, Timber, Economical Design of.....	58	Cableways, The Lidgerwood, Capacity, with Steel Sills, C. B. & Q. R. R.....	44	Derrick, Origin of the Word.....	238
Trucks, Locomotive, in Favor in England.....	259	Car Builders' Demand for Lumber.....	10	Directory of Railroad Officials, Changes in, 16, 32, 48, 68, 88, 126, 151, 202, 210, 278, 316, 354	331
Turbines, Steam.....	259	Car, Coal, Truss for Sides of.....	55	Discipline Without Suspension.....	331
Wheels, Cast Iron, Thermal Tests of.....	107, 221, 229	Car Construction, Uniformity in.....	120	Draft Rigging Car, Cen. Rd. of N. J.....	81
Wheels, Cast Iron vs. Steel-tired.....	332	Car Couplers, Uncoupling on the Road.....	138	Draft Rigging With Pockets vs. Tail Pins.....	129
Wilson-Squire Bill for Improving Status of Engineers in the Navy.....	78	Car Couplers, Unlocking Gears for.....	130	Draft Rigging with Steel Sills.....	320

MISCELLANEOUS.

Abrasion Testing Machine, The Riche.....	67	Car Doors, Freight, Circular of Inquiry on.....	25	Electric Cars, Cost of Repairs.....	346
Abrasion Tests of Iron and Steel, Cambria Iron Co.....	322	Car Ends and Platforms, Passenger, Report to M. C. Ass'n.....	198	Electric Locomotives, Baldwin-Westinghouse.....	47
Aerodrome, Prof. Langley's.....	120	Car, 46-foot Furniture, C. M. & St. P. Ry.....	208	Electric Locomotive on Manhattan Elev. Rd.....	268
Africa, A Warning Against.....	16	Car, Freight, Campbell's Combination.....	6	Electric Locomotive, The New Heilmann.....	284
Air and Gas Compressors, The Norwalk.....	177	Car Heating by Steam.....	293	Electric Motor Power on the Ill. Cen. Rd.....	14
Air-brake Cylinders, Location of, Report and Discussion Before M. C. B. Ass'n.....	129, 198	Car Heating, Gold's Improved Jet System of Hot Water Circulation for.....	31	Electric Motor, The Gibbs Portable.....	65
Air-brake Gear, with Independent Hand- brakes.....	292	Car, Hepper Gondola, Cen. Rd. of N. J.....	80	Electric Motors, Should Steam Roads Adopt Them to Compete with Electric Roads.....	98
Air-brake Hose, Mending of.....	130	Car Lighting, Comparative Cost of City and Pintch Gas for.....	116	Electric Motors, Why They Revolve.....	265
Air-brake Hose, Tests of.....	127	Car Lighting, Mail.....	16	Electric Traction on Steam Rys.....	338, 344
Air-brake Men, Convention of Ass'n of.....	76	Cars, Metal, in France.....	285	Engine, a New Naptha.....	301
Air-brake Men, Subjects for Convention of.....	211	Cars, Metal in France, Preservation, Main- tenance and Probable Durability of.....	171	Engine Board, N. & W. Ry.....	302
Air-brake Suit, The Westinghouse-Borden.....	34	Cars, Metal Underframes for, Discussion be- fore M. C. B. Ass'n.....	129	Engine, Quadruple Expansion Marine.....	115
Air, Compressed, See Compressed Air.....		Cars, Private for Queen Victoria.....	26	Engine, Steam, Experiments on at Lieke.....	288
Air Jack for Raising Driving Boxes, N. Y. C. Rd.....	5	Car Seats, The Bushnell.....	121	Engine, The Bates Thermic.....	285
Acetylene, Explosive Qualities of.....	344	Car Steel flat, carrying 40 tons.....	285	Engineers in the Navy, More Required.....	325
Altoona Shops of the Pennsylvania Railroad.....	89, 165, 203, 241, 279, 317	Car Truck, The Schoen Pressed Steel.....	66	Equipment Notes.....	1, 17, 33, 49, 69, 122, 147, 156,
American Railway Master Mechanics' Asso- ciation, See Master Mechanics' Ass'n.....		Car, Twin-hopper Gondola, Nor. Pac. Rd.....	35		227, 264, 306, 352
American Society of Mechanical Engineers, Program for Convention of.....	81, 351	Car, Fader dump.....	238		
American Society of Navigation Engineers.....	270				
Armored Cruiser Brooklyn, U. S. Navy.....	249				
Annual Report of Mich. Peninsular Car Co.....	315				
Anvil, Spring-Supported, for Drop-Testing Machines.....	61				
Apprentices, Admission of to Purdue.....	94				

AMERICAN ENGINEER

CAR BUILDER AND RAILROAD JOURNAL.

JANUARY, 1896.

CONTENTS.

Page.	Page.
ILLUSTRATED ARTICLES:	Location of Atchison's
Construction and Maintenance of Railway Car Equipment..... 2	Officers..... 3
Two Notable Locomotives..... 4	Sleeping Car Rates..... 5
Special Shop Tools..... 6	Pennsylvania Railroad..... 7
Campbell's Combination Freight Reorganization..... 7	An Extended Use of Copper..... 7
A Water-Tube Boiler for Locomotives..... 9	Proposed Michigan Central Bridge At Detroit..... 9
The Most Advantageous Dimensions for Locomotive Exhaust-Pipes and Smoke Stacks..... 11, 12, 13	Oil Fuel in the Navy..... 9
Improved Car Bracing Cutting-Off Saw..... 15	Central Railway Club..... 9
The Lake Portable Key Sealer..... 16	Exhibits at the Next Conventions..... 9
EDITORIALS:	A President's Private Car..... 9
Announcement of Consolidation..... 8	The Fastest Regular Train..... 9
Reducing Journal-Box Friction..... 8	Personal Mention..... 10
Passenger Train Detentions..... 8	The Greatest Auction Sale..... 10
MISCELLANEOUS:	Burglar Proof Express Cars..... 10
Paragraphs..... 1	The Car Builders' Demand..... 10
Reading Reorganization Plan..... 2	Prospects of Electric Motive Power on the Illinois Central..... 14
Master Mechanics' Association Circulars..... 3	An Extraordinary Locomotive..... 14
	Evaporative Trials of Belleville Rollers..... 14
	The Root Rollers All Right..... 14
	A Model Train..... 15
	A Railroad Struggle Compromised..... 15
	Manhattan Elevated Railway Affairs..... 15
	The Switzerland of America..... 16
	Africa for Africans..... 16
	Safe Lighting of Mail Cars..... 16
	Boiling Liquid Fuel..... 16
	Our Directory..... 16

The Mexican Central is in the market for 150 box and 50 stock cars.

The Duluth, Missabe & Northern has ordered 400 new ore cars.

The Metropolitan Elevated Railroad of Chicago, has ordered 25 new passenger cars.

The Chicago & Grand Trunk is about to order four passenger cars.

The Cleveland, Cincinnati, Chicago & St. Louis will shortly order six parlor cars.

It is stated that the Pennsylvania Railroad is about to order 2,000 new box cars.

The Louisville, New Albany & Chicago Railroad has recently ordered 100 new stock cars.

The Portland & Rochester Railroad has ordered 15 new gondola coal cars of 60,000 pounds capacity.

The Toledo, St. Louis & Kansas City will shortly purchase 500 gondola cars.

The Peru (Ind.) shops of the Erie Railway, have just completed 50 refrigerator cars for a brewing company in Cincinnati.

The New York, New Haven & Hartford has increased the wages of freight brakemen west of New London from \$1.90 to \$2 a day and firemen from \$2 to \$2.10.

The Southern Pacific discharged several hundred men employed in its shops at Sacramento, on Dec. 7. The force was reduced about one-fourth.

The Denver & Rio Grande is having 350 new freight cars built for early delivery. They are to be of 60,000 pounds capacity.

The four boys who wrecked the fast mail train on the New York Central in November are being held for trial on the charge of murder in the first degree.

The Midland Terminal Railway completed its road to Cripple Creek Dec. 19, and the first train from Denver ran direct into the town on that day.

An express car in transit on the Pennsylvania road caught fire and was consumed Dec. 18, all its contents being destroyed except the safe.

The boiler of a Pennsylvania Railroad locomotive exploded at Princeton Junction on the night of December 23, instantly killing the engineer and wrecking several cars.

It is stated that a large concern for the manufacture of street cars will be built near Steubenville, O., by capitalists from Chicago, Pittsburgh and Wheeling.

The Midland Terminal Railroad, of Colorado, is in the market for five locomotives, and will also soon purchase 10 passenger cars and 100 freight cars.

The Boston & Albany is about to order several locomotives similar to the Schenectady locomotives built last year for handling the limited trains between Springfield and Albany.

What is said to be the largest pane of plate glass in the country is in a window in Hartford, Conn. It was made in Belgium, and is 12½ feet high, 15½ feet wide, half an inch thick, and weighs 1,800 pounds.

The Illinois Central will soon order an additional 200 cars. The specifications include the American steel freight car truck manufactured by the American Steel Foundry Company of St. Louis.

It is now reported that Mr. Webb will remain in the London & North Western Railway as its mechanical engineer, the rumors of his retirement being apparently groundless.

The Northern Pacific earned nearly \$400,000 more in November last than in November, 1894. The statement just issued is as follows: Net earnings, November, 1894, \$783,019; November, 1895, \$1,178,592; increase, \$395,573.

The approximated gross earnings of all lines of the Achison, Topeka & Santa Fe Railway for December were \$813,608; for the same period of 1894, \$759,772; increase, \$53,836.

The dedication ceremonies of the new engineering laboratory of Purdue University, Lafayette, Ind., were held Wednesday, Dec. 4. This building replaces the old laboratory which was destroyed by fire on the night of Jan. 23, 1894.

It is stated that the new Board of Directors of the Atchison road has abrogated the old agreement with the Pullman Company, and that it will probably follow the example of the St. Paul road in running its own sleeping cars.

The United States Car Company has secured an order from the Chattanooga Southern Railroad Company for 100 cars, which will be built at the Anniston shops. This plant has just been made ready for operation, after being closed about two years.

Late in December a report was current in Baltimore to the effect that a consolidation of the Baltimore & Ohio Railroad and the Southern Railway is among the possibilities of the near future. This would be a transaction of the greatest magnitude and would combine in one vast system nearly 7,500 miles of road.

The flat has gone forth that in future all carriages run upon the West Coast Scotch expresses shall be bogie vehicles; all the six-wheeled and radial axle box stock is to be withdrawn, and all the eight-wheeled carriages with radial axle boxes are to be sent to Wolverhampton and put on bogies.

A meeting of the stockholders of the New York and Long Island Railroad was held on Dec. 15 in New York. It was voted to increase the capital stock of the company from \$100,000 to \$20,000,000. The plan is to construct a railroad tunnel from Long Island City under New York to Jersey City.

Tramps have been making sleeping quarters of the depots along the Philadelphia & Reading Railroad. Several small stations have been burned. The officials of the road had a raid made on the tramps recently, capturing 31. They were taken to Norristown and placed in the workhouse.

The Baldwin Locomotive Works are building an eight-wheel locomotive for the Jacksonville, Louisville & St. Louis Railroad. The engine will have 17 inch by 24 inch cylinders, and will weigh about 96,000 pounds, 60,000 pounds of which will be carried on the drivers, which are 63 inch diameter and have Baldwin wrought iron centers.

The Delaware, Lackawanna & Western is becoming famous for its frequent and disastrous train wrecks. On Dec. 15 it experienced a rear end collision of freight trains near Dover, N. J., that instantly killed a stockman and a large number of live stock. A locomotive and several freight cars were wrecked.

Is there to be no limit to the development of the trolley car? There are trolley postal cars, trolley party cars, and trolley theater cars are promised. And now comes forward a genius who seriously proposes to run trolley lunch or dining cars, enabling busy men to take their meals while on their way to or from business.—*New York Tribune*.

The Westinghouse Air-Brake Company on Dec. 9 filed in the United States Circuit Court for the District of Maryland a complaint in a new action against the Boyden Brake Company for infringement of patent No. 360,070. This suit is understood to be directed against the new triple valve which the Boyden Company is now manufacturing.

A bill has been introduced in the United States Senate by Senator Quay, asking for an appropriation of \$25,000 for the Franklin Institute and Purdue University, for the purpose of determining the quantity and effect of hammer blow, "centrifugal lift and tangential throw" of locomotive wheels in use on American railroads; also the effects produced thereby.

While a passenger train on the Siberian Railway was running at a high rate of speed, Dec. 19, the carriage in which Count Golovine was traveling with his wife and two children caught fire. The flames spread so rapidly that the Countess and her two children were unable to escape, and were burned to death. The Count saved his life by leaping from the train.

The American-China Development Company filed articles of incorporation at Trenton, N. J., Dec. 20. The avowed purpose of the corporation is to operate railways, steamship, telegraph and telephone lines in China. The capital stock of the company is \$1,000,000. Among the incorporators are Frank Trenholm, of New York; D. H. Lyon, of Greenwich, Conn., and S. S. Walters, of Jersey City.

The Pennsylvania Railroad is building from a point on the New York division near North Penn. Junction to Bustleton, from which an extension will be made about 16 miles to the vicinity of Trenton. The completion of this branch will give it almost an air line between Trenton and Philadelphia. It will be used specially for fast trains. Surveys are being made with a view to cutting off about a mile between Harrisburg and Altoona.

The proverbial three wrecks occurred on the Norfolk & Western Railroad, in Virginia, between midnight and morning, Dec. 11. The first occurred at the Norfolk & Southern Junction, a few miles west of Norfolk; the second near Windsor, and the third about three miles from Ford's Station. The trains were freights, and almost 20 cars were wrecked. The tracks were badly blocked, and all trains were delayed from two to three hours. No one was injured.

A French journal describes a new and promising substitute for gold. It is produced by alloying ninety-four parts of copper with six of antimony, the copper being first melted and the antimony afterward added; to this quantity of magnesium carbonate is added to increase its specific gravity. The alloy is capable of being drawn out, wrought and soldered just as gold is, and is said to take and retain as fine a polish as gold. Its cost is a shilling a pound.

The New York State canals were officially closed on Dec. 5. In spite of low railroad rates, the past season has been a fairly good one for the boatmen. The total falling off in tons carried on all the canals during the season of 1895 was only about 10 per cent. In 1894 the number of tons carried was 3,882,560. This year, up to Dec. 1, the number of tons carried was 3,467,848, a loss in tons of 414,712. The clearance since December will reduce the difference somewhat.

The *Railway Herald* says: The West Coast Joint Stock is to be increased by 100 new bogie carriages, which are to be built at the London & North Western Railway works, at Wolverton. We trust that they will be fitted with that system of spiral suspension-bolster springs already adopted by the London & North Western Railway, which gives much better results with regard to steady and smooth running than the ordinary elliptical laminated springs formerly in use.

The production of pig iron in 1895 has verified the predictions made early in the year that if the rate of output at the time was maintained for the year the record of tonnage would be exceeded. The total output according to official figures compiled by the *American Manufacturer*, shows a production of 9,887,639 tons, exceeding 1890, the largest previous year, which had a tonnage of 9,202,703 tons. In 1892 the output was 9,157,000 tons. The tonnage of 1894 is exceeded by 730,251 tons.

All efforts to straighten out the Northern Pacific receivership tangle have proved unavailing. Repeated conferences have been held, but each succeeding discussion has widened the gulf between the Eastern and Western interests. Authentic information states that the Eastern interests which seem to be opposed to Judge Hanford have determined if possible to secure the passage of a law by Congress this winter, the effect of which will be to deprive Judge Hanford of jurisdiction. This, it is said, explains the long delay in approaching the adjustment of the united receivership of the road.

A happy instance of possible justice being tempered by sure mercy was the Thanksgiving proclamation of Superintendent Charles A. Beach, of the Buffalo division of the Lehigh Valley Railroad, stating that: "The Thanksgiving of such employees as have, unfortunately, been suspended for infractions of discipline, may not be a disappointing one, all such are hereby notified that the balance of their term of suspension need not be served; they may resume work at once." We are sure that the interests of the company were advanced by this act quite as much (and in dollars and cents much more) as were those of the employees concerned.

Truckee, a little town on the Central Pacific, which is very near the Nevada line and also very close to the summit of the Sierra Nevada range, proposes to open on Jan. 1 an ice palace which will have some novel features. There will be toboggan slides and skating ponds, but what makes it unique is that only 80 miles away, at Newcastle, orange groves will soon be in bloom and the trees now hang heavy with the golden fruit. The difference between the two places is solely the difference of altitude, but it is doubtful if any part of the world, except Hawaii, can afford such remarkable contrasts of climate within the same distance. Truckee also promises sleigh rides to Lake Tahoe, one of the most beautiful sheets of water in this country.

Construction and Maintenance of Railway Car Equipment. I.

BY OSCAR ANTZ.

About seven years ago a series of articles was published in these columns, and afterward in book form, by Mr. Wm Voss, on the construction of railway cars. These articles covered the subject pretty thoroughly as far as the cars then in use were concerned, but since then the demand for cars of larger carrying capacity and greater strength, and of others adapted to different purposes, has brought about changes in the dimensions and design, and in some cases has led to new types of cars differing from those then in existence.

The natural tendency to progress and improvement has brought into use a large number of appliances of more or less meritorious design, and the necessity of equipping freight cars with power brakes and automatic couplers to comply with national legislation has filled the market with the results of the ingenuity of inventors; and it will be the purpose of this and some subsequent articles to describe the improvements made in railway car equipment in the last few years, and to outline the possible changes which may take place in the near future. It is not intended that these articles should be an elaborate description of every kind of car in use, but merely to give a general idea of the best practice as it exists today in this country in the construction of railway cars.

later years, when many cars were built by car manufacturers and not by the railroad companies each one of these manufacturers had his own ideas and as they were usually not restricted to any details further than perhaps the kind, size and cost of the cars, the result was that if they patronized different manufacturers, railroad companies often had a great variety of such equipment.

Therefore, we find among the older cars almost as many different kinds as there are numbers, and when it is necessary to renew any part the old piece must often be obtained to make the new one from it. Very few drawings were made in those days, and each part had to be put in place before the next one was started. Castings and forgings were made to fit as occasion would require, and, especially where a foundry was conveniently near, each car often had some casting peculiar to itself.

At the present time, with the enormously increased number of cars and the large amount of interchanging of traffic between different roads, the question of repairs has become quite a serious one, and cars are now built so as to facilitate as much as possible the repairs of such parts as most frequently fail in service. Furthermore, the same parts in different kinds of cars are made alike whenever possible. Castings especially are reduced in variety, and even in the early days of the Master Car Builders' Association standards were established for a number of castings which were adopted by many roads.

Some of the standards for certain parts were, however, not established by the Master Car Builders' Association

There is still a wide discrepancy in the size and shape of similar parts of cars on different roads, and in the limited description which can at best be given in these articles, only such as seems to be the average good practice will be touched upon.

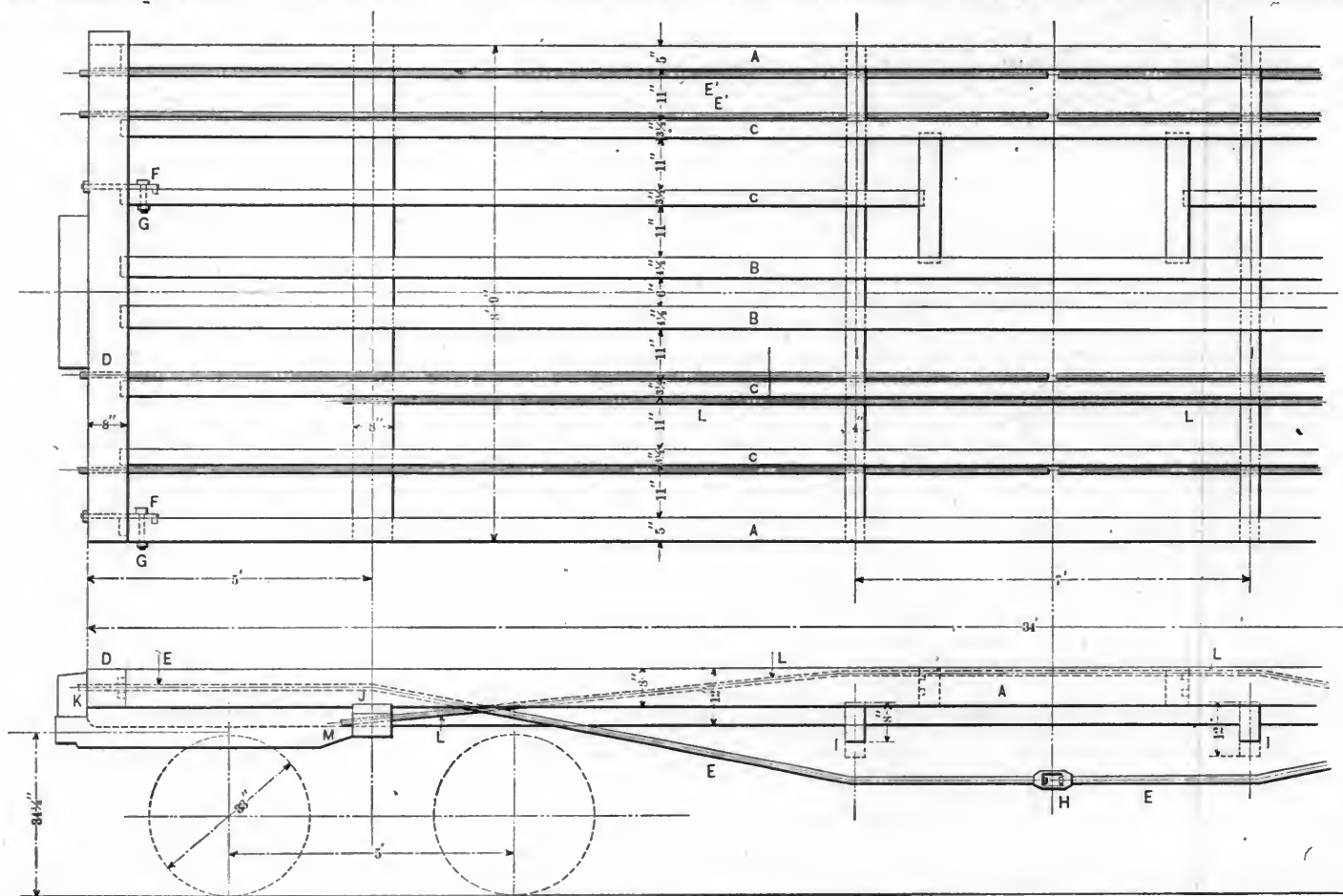
CAPACITY.

Nearly all freight cars that have been built in later years have a capacity of 60,000 pounds or more, and probably it will be but a short time before most cars of smaller size will be taken out of service or be assigned to remote divisions where the traffic is light, or to some special service in which they will not be put into the same trains with heavier cars. Some cars of over 60,000 pounds capacity are at present in use; ore cars of 80,000 pounds capacity have been in use for several years on a number of roads; coal cars of a capacity of 70,000 pounds have recently been built in considerable numbers by another road, and the building of cars of 80,000 pounds capacity for regular service is receiving serious consideration throughout the country.

These large cars may, however, be considered as yet in the experimental stage, and they will be treated by themselves later on; in the description immediately following only cars of 60,000 pounds capacity will be considered.

DIMENSIONS.

The length of a 60,000-pound freight car is generally from about 34 to 36 feet long over its end sills; the former length is largely adopted by roads which do not use an end platform; the latter length is necessary with end platforms to get an effective inside length of about 34 feet.



FIGS. 1 AND 2. SHOWING COMMON ARRANGEMENT OF FLOOR FRAMING AND TRUSSING OF FREIGHT CARS.

It is, furthermore, not pretended that very much, if any, new matter will be presented, as nearly every new car which has been put into use in the last few years has been more or less described and illustrated in the railroad and engineering journals, and a series of articles like these can only give in a general way the improvements made over the old practice, and the latter must be referred to at times to illustrate the new methods.

UNIFORMITY IN CAR CONSTRUCTION.

With the developments of modern railroading and the large amount of interchanging of cars among the different roads the necessity for uniformity in their different parts and especially of those used in freight service, not only of one road but of all railroads of the country is made more and more apparent, and the standardizing of such parts of passenger and freight cars as are most liable to damage and thus needing replacement, has been a most important part of the work of the Master Car Builders' Association.

In the earlier days of railroading cars were built according to the ideas and prejudices, often, of the person in charge of the car department of the road for which they were intended, without much regard to others on the same or other lines, and without making much provision with reference to repairing them. The length of the cars was often determined by the length of the timber which happened to be on hand for sills and the size of many other parts was also dependent the material on hand. In

until some roads had adopted different standards of their own, and had built cars according to them. These roads were naturally not very desirous of changing to some other plan perhaps not better than their own, and we therefore find even in modern cars many variations from the M. C. B. standards, which make more or less trouble on roads which adhere strictly to these standards.

In order to avoid, if possible, this state of affairs in future, standards should be established in advance for cars differing in capacity from those now in existence, and which the requirements will from time to time demand, and the Master Car Builders' Association has already taken up the subject of standard parts for freight cars of 80,000 pounds capacity, which it seems from present indications will be one of, if not the, freight car of the near future.

It should be the endeavor of all car builders to follow these standards, when adopted, indiscriminately, even if necessary to discard a pet idea or former practice.

FREIGHT CAR CONSTRUCTION.

A description of those freight cars for the railroads of this country which have been built in recent years can be based on the supposition that the necessity for standardizing this equipment has been recognized by railroad managers and that the cars have been built in pursuance of this policy, the subject can then be treated first in general way, describing such parts as are usually alike in all classes of cars, and then taking up each class individually.

The width of these cars varies from 8 feet 6 inches to 9 feet over the side sills, depending somewhat on the attachments on these sills, as the width over all must be kept within certain limits.

In these dimensions there has been practically no change from lighter cars, those of 40,000 to 50,000 pounds capacity having been built of about the same size; the height, however, on cars with a superstructure has been generally increased.

The height is determined by the class of the cars and the service in which they are employed. Closed cars, having a roof and side doors can be built as high as obstructions on the road will allow, while open or gondola cars which must be loaded over the sides be low enough to be loaded with economy. These dimensions will be given under their proper heads.

There is a demand at present for box cars of a larger internal cubical space than that which the ordinary box cars have, and of the same weight carrying capacity. This demand is the result of an arrangement of freight rates by which certain minimum weights are charged for, on light and bulky material in car load lots, even when the load does not weigh the prescribed amount. Naturally the shippers of this kind of freight demand large cars and the "Large Car Question" is now receiving a good deal of attention from railroad men.

Furniture cars have been built by some roads to meet this demand and these will be described later. Their usual

dimensions, which are given here for comparison, are: length, 40 feet over end sills; width, slightly less than 10 feet over all, and extreme height about 13 feet.

FLOOR FRAME.

The increased capacity of freight cars necessitated a general strengthening of parts, and we meet this first in the floor frame.

In Figs. 1 and 2 is shown a floor frame which can be taken as an average of ordinary cars, the length shown being 34 feet over end sills; the upper half of the plan view represents the frame of a car having a central opening for drop doors, the lower part showing one for a solid floor.

LONGITUDINAL SILLS.

The longitudinal sills are eight in number and are usually of yellow or Norway pine; they are almost universally 8 inches in depth, excepting on cars without any framed superstructure, on which the side sills, *AA*, are made stronger, generally 12 inches deep.

The width of these sills varies more or less with different builders, but is usually $\frac{1}{2}$ or 5 inches for center, *BB*, and side sills, *CC*, and $\frac{3}{4}$ or 4 inches for intermediates.

The spacing of the sills is determined somewhat by other details of the car, thus the center sills are spaced to suit the draft rigging, and the intermediates depend somewhat on details of body bolster and on truss rods for their location, but it is usually endeavored to get as nearly an even spacing as is possible, with the center sills in the line of greatest stress.

On cars having a low frame, such as furniture cars, it is furthermore necessary to space the sills so as to allow the car to move over sharp curves without having the wheels strike the sills. When a certain spacing has been decided on as a standard, it should be adhered to as far as possible even on cars of different width, the difference being allowed between the outside intermediate and the side sill; this will bring all parts of the body bolsters alike, excepting the ends. The longitudinal sills are framed to the end sills, *D*, usually by double tenons, and are held to them by the body truss rods, *EE*; additional strength is given by bolts, *FF*, passing through the end sills and ending in a plate and lug; the lug is let into the longitudinal sill and a bolt, *GG*, passing through the sill and plate, holds them securely. These lug bolts should always be provided where the end sill is unsupported for any unusual distance by truss rods, or when a truss rod does not come close to the side sill. In the latter case these bolts can be utilized to hold the corner plates, if these are used.

The floor frame of freight cars is subjected more or less to influences which cause it to rot, and this is especially the case where two pieces of timber are close together allowing water which gets in to remain there, as it does between the tops of sills and the bottom of the floor, and in the joints between the sills. To prevent this tendency to rot a liberal coat of "Fenoline" oil should be applied to these places before the timbers are put together.

END SILLS.

The end sills, *D*, of freight cars are subjected to severe blows and must be made very strong. They are usually made of oak, although in the South yellow pine is sometimes used.

End sills are not less than 8 by 8 inches in section and are often made larger than this. They are almost universally now framed to the ends of all of the longitudinal sills, thus extending to the extreme width of the car. Where they are not enclosed by sheathing, or where corner bands are not used, they should extend a few inches beyond the side sills.

TRUSS RODS.

With the general strengthening of the cars, the trussing of the frame has also undergone some changes and there are now at least four truss rods, which are $\frac{1}{2}$ inches or more in diameter, with the ends enlarged so that the area at the bottom of the screw threads which are cut on them equals or slightly exceeds that of the body of the rod.

The rods are made in two parts, joined at the center of the car by turn buckles, *H*, with right and left hand screws; these turn buckles are prevented from turning, when screwed up, by pieces of wood passed through two or more of them, and held place by bolts or lag screws through the wood on the sides of the turn buckles.

The truss rods pass under bearings or "queen-posts" on the cross-tie timbers, *II*, which are generally about 8 inches deep, then over saddles on the body bolster at *J*, and then through the end sills, *D* at *K*, where large washers are placed under the nuts on the rods. Some builders put cast-iron sockets in the end sills for the truss rod nuts to rest in, so as to have no projections over the face of the sill.

The bends in the rods should not come quite close to the saddles and bearings, as there is a liability of tilting these when the rods are being screwed up, if the bends come hard against the casting.

The location of the truss rods with respect to the longitudinal sills is determined somewhat by the attachments on the end sills, and furthermore they must be so placed that they will not come in contact with the wheels or other parts of the trucks. Other details which determine the location are doors in the floor and the air-brake apparatus. In the upper part of Fig. 2, the two truss-rod *EE* are shown between the side sill and outside intermediate, as they would come in the way of the doors if located nearer the center of the car.

It is usual to place the rods close to some of the longitudinal sills, so as to tie these well to the end sills and to get a good fastening for the truss-rod saddle.

Flat or platform cars, having no superstructure at all, are liable to be bowed up at the center when empty and placed between heavy cars when the train is suddenly stopped. To resist this tendency, inverted truss rods, *LL*, of $\frac{3}{4}$ or 1-in. round iron are therefore used, which rest in saddles on the cross-tie timbers. These rods are located as high as they can be between the timbers and the floor, and their ends pass through the body-bolsters at *M* with large washers and nuts bearing on these, the ends of the rods being enlarged for the threads.

CAMBER.

If the top of a car were made perfectly straight it would sag down at the center when loaded. The truss-rod resist this tendency to some extent, and to further stiffen the car it is given camber; that is, it is curved upward at the center to $1\frac{1}{2}$ to 1 $\frac{3}{4}$ inches from a straight line. This camber is obtained usually by drawing the frame down at the ends by means of turn-buckles made fast to the floor of the shop and raising up at the center by jacks. On cars with a framed superstructure this camber is preserved by making the braces and posts of the proper length and by the introduction of tie and brace-rods, and the truss-rods are used as an additional means of holding the car up under load. On cars without any framed body the camber is preserved entirely by the body truss-rods.

When in service, body truss-rods should be tightened up frequently to preserve the camber and to prevent the wearing of the joints between the sills and the consequent racking of the car.

CROSS-TIE TIMBERS.

Cross-tie timbers do not add much to the strength of a car, being used principally to hold the longitudinal timbers in place laterally at the center of the car and keep them from spreading, and also to provide a support for the truss-rod bearings. They are usually made of the same material as the end sills, and are about 4 by 8 inches in section, and extend to the outside of the side sills; they are gained or notched out a half inch for each longitudinal sill. There are generally two cross-tie timbers to a car, spaced from 6 to 8 feet apart. Some cars are occasionally found with only one of these timbers at the center of the car.

When the side sills are deeper than the other sills of a car, the cross-tie timbers are also made correspondingly deeper, and are cut out the same amount under the side sills. The cross-tie timbers are fastened to the longitudinal timbers by $\frac{1}{2}$ -inch bolts, one at each timber, and some of these bolts usually held the body truss rod bearings also. Some builders place the cross-tie timbers slightly out of plumb to better resist the pressure from the truss rods.

(To be Continued.)

Reading Reorganization Plan.

The plan for the reorganization of the Philadelphia & Reading Railroad Company and its subsidiary companies was made public Dec. 15. Under the plan the following securities will be created: General mortgage 100-year 4 per cent. bonds, \$114,000,000; non-cumulative 4 per cent. first preferred stock, \$28,000,000; non-cumulative 4 per cent. second preferred stock, \$42,000,000; common stock, \$70,000,000.

The general mortgage will provide for the issue, if found desirable, of additional bonds to meet the outstanding Philadelphia & Reading terminal bonds and Philadelphia & Reading Coal and Iron bonds. The mortgage will be based upon properties or securities of all the lines of railroad owned by the company, 327 miles; various leasehold lines, 532 miles, and all property of the Coal and Iron Company representing nearly 200,000 acres of coal and timber land. It will also have the benefit of equipment, valued at about \$10,000,000, but now subject to about \$7,300,000 of car-trust obligations, which are to be acquired under the plan, and also the marine equipment of the company.

Of the bonds \$20,000,000 will be used for new construction, additional equipment, etc., under carefully-guarded restrictions not over \$1,500,000 to be used in any one year. Provision is made that, at any time after dividends at the rate of 4 per cent. a year shall have been paid for two successive years on the first preferred stock, the company may convert the second preferred stock at par, one-half into first preferred stock and one-half into common stock, and the amounts of these latter may be increased in conformity. The assessments are 20 per cent. on the first, second and third preference income bonds; 30 per cent. (\$10 per share) on the stock, and 4 per cent. on the deferred income bonds.

As set forth in the plan, the annual fixed charges of the reorganized system will be about \$9,300,000. An almost immediate reduction of nearly \$500,000 per annum in these fixed charges will, however be effected through the re-funding or extension of the various bonds shortly to mature.

The net earnings of the system for the last four years, terminating Nov. 30, have been: 1892, \$12,472,190.60; 1893, \$11,172,690.56; 1894, \$9,839,971.82; 1895 (estimated), \$9,624,123. With a syndicate of \$48,000,000 behind the undertaking there can be no doubt of the ability to meet all financial requirements that may arise.

Master Mechanics' Association Circulars.

Locomotive Steps and Handholds.

The committee of the Master Mechanics' Association appointed to report upon the subject of steps and handholds on locomotives and tenders has issued a circular of inquiry in which the following questions are asked:

What form of steps and handholds do you prefer leading to gangway of cab?

Do you consider the common arrangement of a step, each, on back of engine and front of tender sometimes confusing and dangerous?

Do you favor the arrangement of wide steps depending from the front of tender frame, dispensing with the engine step?

What arrangement of steps and holds do you prefer leading (1) to the headlight, (2) to sandbox?

What form, if any, of steps and handholds do you use or recommend at back end of tender?

Please forward your replies, with such drawings or prints as may be convenient, to John Medway, Superintendent of Motive Power, Fitchburg Railroad, Boston, Mass.

John Medway, H. Bartlett, J. T. Gordon, F. M. Twombly, G. H. Baker, Committee.

The following circular has been issued by the committee on

Driving-Box Wedges:

Have you ever had any experience with locomotives whose driving-boxes were not put up with adjustable wedges? If so, please give us the results of your observations.

Do you think that a close-fitting box put up between a shoe and a fixed wedge (that could be lined only by a machinist when occasion required), would be a better method of construction than the present one of a movable wedge?

If in favor of the stationary wedge, please say how ought the box to be fitted in order to give the longest mileage without risk of the box sticking when the engine is first turned out?

Will you, for experimental purposes, equip an engine with stationary wedge, and run it some four or five months, and report results to us?

Are not the majority of hot boxes (not hot journals) caused by enginemen setting up movable wedges too tight?

Now that so many side rods have bushed ends, and are therefore not adjustable as to length, is it not advisable to take from enginemen the power of varying the distances apart of the axle centers, as can now be done on an engine with movable wedges?

Do not stationary wedges break off fewer axle box flanges than movable wedges?

If stationary wedges were not used, or in other words, if new engines had the frame pedestals forged with parallel faces and then fitted with pedestal blocks paralleled in every way, so that the new pedestal blocks as they came from the milling machine could be used interchangeably, either front or back, up or down, would it probably increase the risk of failure on the road by fractures of the frames?

Under the above conditions, would the engine tend to come back to shop for repairs, having made less mileage than if equipped with wedges?

Also, under the above conditions, would engine be appreciably less economical in the use of steam, during, say the last half of her mileage?

Will our members oblige the Association, and this Committee, by early replies to the foregoing questions, addressing J. Davis Barnett, Stratford, Ontario, Can.?

J. Davis Barnett, H. A. Childs, T. J. Hatswell, R. Atkinson, R. E. Redding, Committee.

Location of Atchison's Officers.

The headquarters of the executive officers of the reorganized Atchison, Topeka and Santa Fe Railway Company will be located as follows:

In New York—Chairman of the Board, Aldace F. Walker; Comptroller, John P. Whitehead; Assistant Secretary, L. C. Deming, and Assistant Treasurer, George C. Goodwin.

In Chicago—President, E. P. Ripley; First Vice-President, D. B. Robinson; Third Vice-President, Paul Morten; Freight Traffic Manager, W. B. Biddle; Passenger Traffic Manager, W. F. White; General Freight Agent, W. A. Bissell; General Passenger Agent, George F. Nicholson; General Solicitor, E. D. Kenna, and General Auditor, W. K. Gillette.

In Topeka—General Manager, J. J. Frey; Secretary and Treasurer, Edward Wilder; General Superintendent, H. U. Mudge, and Superintendent of Machinery, John Player. In addition these officers will have their headquarters in Topeka. Chief Engineer, General Claim Agent, Assistant General Freight Agent, Assistant General Passenger Agent, Superintendent of Telegraph and Tax Commissioner, Master Car Builder and Superintendent of Car Service.

Among the deep coal mines in Europe is one at Lambert, Belgium. Depth, 3,490 feet.

The Terre Haute Car and Manufacturing Company has passed out of the hands of an assignee and the plant will be put in readiness to begin work in January.

A despatch from Peking states that an imperial edict has been issued ordering the construction of a double-track railway between Peking and Tien-Tsin, a distance of 72 miles. The rails used will weigh 85 pounds to the yard and the cost of construction will be about \$3,000,000.

Two Notable Locomotives.

We herewith present photo-engravings of two powerful simple locomotives built for special heavy fast passenger service on Western roads. Both engines were built by the Schenectady Locomotive Works. Our first engraving shows one of two similar engines built for the Cleveland, Cincinnati, Chicago & St. Louis Railway. According to the designs of Mr. William Garstang, Superintendent of Motive Power of the road. These engines were procured to handle the heavy passenger trains on the grades of the Cleveland & Cincinnati Division from Cleveland to Galion. The train which they are designed to haul is No. 11, leaving Cleveland at 3:30 p. m. and arriving at Galion at 5:40 p. m. The distance covered in these two hours and ten minutes is 79.8 miles and there is a total ascent of 595 feet.

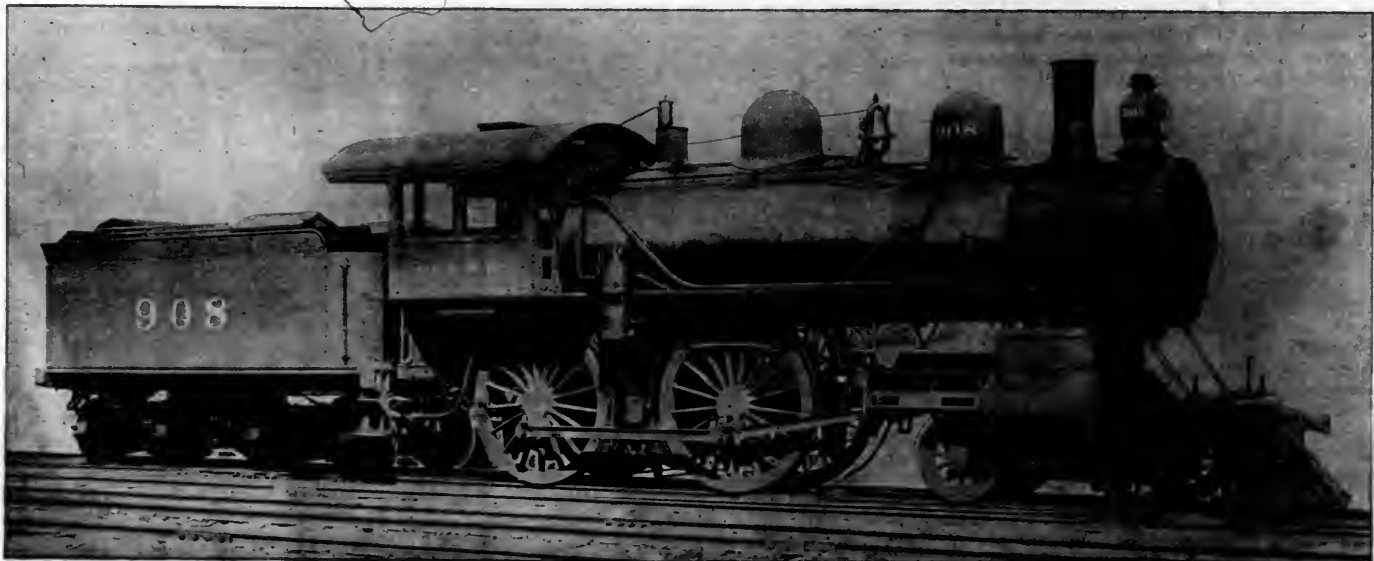
The great height of the engine above the rails prevented the placing of the safety valves on the dome and they were put back of it, as shown in the engraving.

Heating surface, firebox.....	179 sq. ft.
" " tubes.....	1,996 sq. ft.
" " total.....	2,175 sq. ft.
Grate area.....	30.75 sq. ft.
Drivers, diameter.....	72 in.
material of centers.....	cast steel
Truck wheels, diameter.....	33 in.
Journals, driving axle, size.....	8 3/4 x 11 1/2 in.
Main crank pin, size.....	5 1/2 x 6 1/2 in.
Cylinders, diameter.....	20 in.
Piston, stroke.....	24 in.
Kind of piston rod packing.....	Jerome metallic
Steam ports, length.....	20 in.
" " width.....	1 1/2 in.
Exhaust ports, length.....	20 in.
" " width.....	1 1/2 in.
Valves, kind of.....	Allen Richardson
" " greatest travel.....	6 in.
" " outside lap.....	1 1/2 in.
" " inside lap or clearance.....	Line and line
lead in full gear.....	Radial stayed wagon top
Boiler, type of.....	200 lbs.
" " working steam pressure.....	Carbon steel
" " material in barrel.....	4 in.
" " thickness of material in barrel.....	61 in.
" " diameter of barrel inside.....	Double riveted butt
Seams, kind of horizontal.....	14 in.
" " circumferential.....	3/4 in.
Thickness of tube sheets.....	
" " crown sheet.....	

diameter of the boiler at the first ring is 62 inches and the height of center of boiler above rails is 8 feet 8 inches. The diameter of the piston is 3 1/2 inches, except where it enters the crosshead, and there the diameter is increased to 3 1/2 inches. This was done to strengthen it at the point where the most frequent breakages have occurred. Cast iron gibs are used on the crosshead instead of brass ones. Cast steel is used in a great many places in order to get the necessary strength combined with lightness. The piston, crosshead, wheel centers, dome ring and deck plate are made of this material. The whistle is not put on the left hand side of the dome, as is frequently done, but is located at the same place as the safety valve. By this arrangement not only is the dome given a more symmetrical appearance, but should it be necessary to remove the covering, the boiler need not be blown off and the whistle removed. The interior arrangement of the cab is neat, half of the back head of the boiler being lagged and covered with planished iron. Platinum leaf is used for



Heavy Fast Express Locomotive; Cleveland Cincinnati, Chicago & St. Louis Ry.



Heavy Fast Express Locomotive; Chicago & Northwestern Ry.

One of the most striking features of its construction is the large boiler and firebox. The boiler is 72 inches in diameter, and the firebox is 9 feet long. The crown sheet is stayed with radial stays, the first two rows being sling stays. The dome is attached to the boiler by a flanged ring. The total heating surface is 2,175 square feet, about 245 square feet more than the 999 of the New York Central possesses.

The pistons and rods and driving-wheel centers are made of cast steel for lightness. The driver has a cast-iron ring, 1/4 inch thick, shrunk on the inside of the hub. The design of the crosshead is for the standard four-bar guides used on this road. The pistons are hollow, and have a plate of boiler steel 1/4 inch thick as a cover on the head end. Dunbar packing is used. The engine truck is of the rigid-center type, with a wheel base of 79 inches. The center plate is of cast iron. The following table gives the general dimensions:

Kind of fuel to be used.....	Bituminous coal
Weight on drivers.....	83,000 lbs.
" " truck wheels.....	43,000 lbs.
" " total.....	126,000 lbs.
Wheel base, total, of engine.....	23 ft. 10 1/4 in.
" " driving.....	8 ft. 6 in.
Height, center of boiler above rails.....	8 ft. 6 1/2 in.

Tubes, number.....	320
" " material.....	Knobbed charcoal iron
" " outside diameter.....	2 in.
" " length over wheels.....	12 ft.
Firebox, length.....	9 ft.
" " width.....	3 ft. 8 in.
" " depth front.....	76 in.
" " back.....	64 in.
" " material.....	Carbon steel
" " thickness of sheets.....	1/4 in.
" " brick arch.....	Yes
" " water space, width.....	Front 4 in.; sides 3 1/4 in.; back 4 in.
Grate, kind of.....	Rocking finger, with drop plate
Smokebox, diameter outside.....	65 in.
" " length.....	6 1/2 ft.
Netting, wire or plate.....	Wire netting
size of mesh or perforation.....	Three meshes per inch
Stack, straight or taper.....	Straight

Our second engraving shows one of 12 eight-wheel passenger engines recently built for the Chicago & Northwestern Railway for heavy fast service between Chicago and Council Bluffs. The trains hauled sometime consist of 11 cars, six of which are sleepers. While the average speed between terminals is not very fast, yet there are numerous stops, causing fast running between, making it an exceedingly hard service.

The driving wheels are 36 inches, and the truck wheels are 36 inches. The cylinders are 19 inches by 24 inches, and the firebox is 8 feet and 1/4 inch long. The

the numbers and lettering, and presents a handsome appearance.

The following gives the principal dimensions and points of interest:

Kind of fuel to be used.....	Bituminous coal
Weight on drivers.....	78,000 lbs.
" " truck wheels.....	47,600 lbs.
" " total.....	125,600 lbs.
Wheel base, total, of engine.....	23 ft. 7 in.
" " driving.....	8 ft. 6 in.
" " total (engine and tender).....	47 ft. 6 in.
Height, center of boiler above rails.....	8 ft. 8 in.
" " of stack.....	14 ft. 11 in.
Heating surface, firebox.....	159.3 sq. ft.
" " tubes.....	1,715.6 sq. ft.
" " total.....	1,874.9 sq. ft.
Grate area.....	26.96 sq. ft.
Drivers, diameter.....	36 in.
material of centers.....	Cast steel
Truck wheels, diameter.....	36 in.
Journals, driving axle, size.....	8 in. dia. x 11 in. long
" " truck.....	6 in. dia. x 10 in. long
Main crank pin, size, main rod.....	5 1/2 in. x 5 1/2 in.; side rod, 4 1/2 in. dia. x 4 in. long
Cylinders, diameter.....	19 in.
Piston, stroke.....	24 in.
" " rod, diameter.....	3 1/2 in.
Kind of piston rod packing.....	Jerome metallic
Main rod, length center to center.....	7 ft. 7 1/2 in.
Steam ports, length.....	20 in.
" " width.....	1 1/2 in.
Exhaust ports, length.....	20 in.
" " width.....	1 1/2 in.
Bridge, width.....	1 1/2 in.

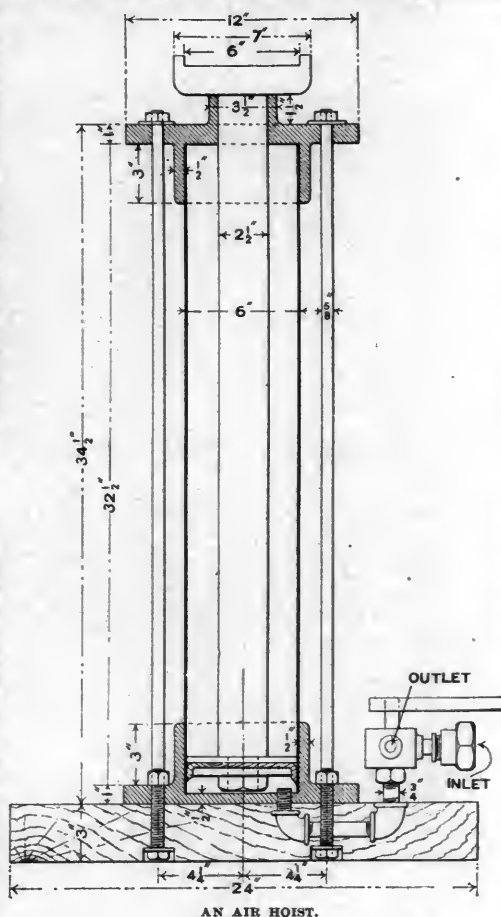
Valves, kind of.....	Allen-Richardson Balanced
" greatest travel.....	6 in.
" outside lap.....	1 1/4 in.
" inside clearance.....	1/4 in.
" lead.....	1/4 in. lap in full gear forward motion and back eccentric set to give 1/4 in. lead at 6-in. cut-off forward motion.
Bolter, type of.....	Extended wagon top
" working steam pressure.....	180 lbs.
" material in barrel.....	Carbon steel
" thickness of material in barrel.....	7/8 in.
" diameter of barrel at first ring.....	62 in.
Seams, kind of horizontal.....	Multiple riveted, butt with weld inside and outside
" circumferential.....	Double riveted
Thickness of tube sheets.....	1/4 in.
Crown sheet stayed with.....	Radial stays 1 in. diameter
Dome, diameter.....	30 in.
Tubes, number.....	287
" material.....	Syracuse Iron No. 11
" outside diameter.....	2 in.
" length over sheets.....	11 ft. 6 in.
Firebox, length.....	8 ft. 3 in.
" width.....	3 ft. 4 1/4 in.
" depth front.....	77 1/4 in.
" back.....	65 1/4 in.
" material.....	Shoenberger steel
" thickness of sheets.....	Back and sides, 3/8 in.
" brick arch? Yes.....	Supported on four 3-in. tubes
" water space, width.....	Front, 4 1/4 to 5 in.; sides, 4 to 4 1/4 in.; back, 4 in.
Grate, kind of.....	Rocking, with drop plate
Smokebox, diameter outside.....	63 in.
" length from flue sheet.....	66 1/4 in.
Exhaust nozzle, single or double.....	Single
" diameter.....	4 1/2 in., 5 in. and 6 1/4 in.
" distance of tip below center of boiler.....	1 1/4 in.
Netting, wire or plate.....	Perforated plate
" size of perforation.....	1 1/4 in. by 3/4 in.
Stack, straight or taper.....	Cast iron, taper
" least diameter.....	Near bottom, 14 in.
" greatest diameter.....	At top, 16 1/4 in.
" height above smokebox.....	3 ft. 6 1/4 in.

Special Shop Tools.

Stack Base Dies.

Among the many other special tools that have been made and are in use in the shops of the Philadelphia & Reading Railroad at Reading, Pa., are the dies that are used under the steam hammer for stamping out the bases for the smoke-stacks. The one illustrated is that used for stamping the bases for 20 inch stacks. It will be seen to consist of a cast-iron matrix finished to the curve and outside diameter of the base. This is keyed to the anvil, while the stamp is keyed to the hammer head as indicated by the center figure on the left. The process is exceedingly simple, the heated plate is put over the matrix, and the head coming down forces it into shape. It is the impression of many that hydraulic pressure is alone suited for this class of work, but it is a mistake. A wide range of stamping and pressing can best be done with the steam hammer. The Schoen Manufacturing Co., for example, stamp out all of its center plates under the hammer, and do it with a rapidity that could not be approached by the hydraulic press. The same statement holds good with regard to these

tral & Hudson River Railroad for raising driving-boxes in the jaws. It is formed of a piece of 6-inch brass tubing set in castings at each end, and which form the top and bottom. They are held together by four 1/2-inch bolts. The piston rod is a bar 2 1/2 inches in diameter with a 1/2-inch plate and a cup-packing bolted to the lower end. At the top there is a casting having a shape suitable for holding the boxes.

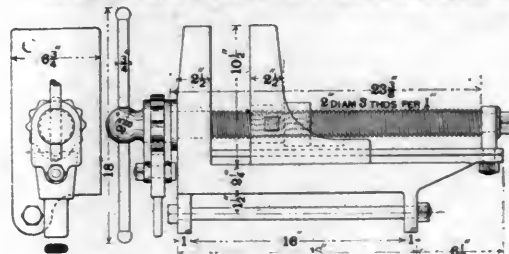


AN AIR HOIST.

jaw can be rapidly run up by the hand lever in the usual way and the final tightening secured by the ratchet lever to which a long handle can be attached. It is simple, strong, cheap, rapid in action and home-made.

Attachment for Slotting Boxes.

Here is another from the same Reading shops that are so rich in special contrivances. This is especially designed for slotting the curved face in driving-boxes, the tool is carried at the lower end of a spindle that is fitted, at the upper end, with a clutch engaging a worm gear. This worm gear meshes with a worm on the spindle shown in the plan as standing at an angle of 45 degrees with the center line of the machine. After the box is brought to a central position with the cutting spindle the tool can evidently be given a circular feed by turning a hand-wheel on the 45-degree spindle. The power feed is obtained by means of the grooved friction wheel on the 45-

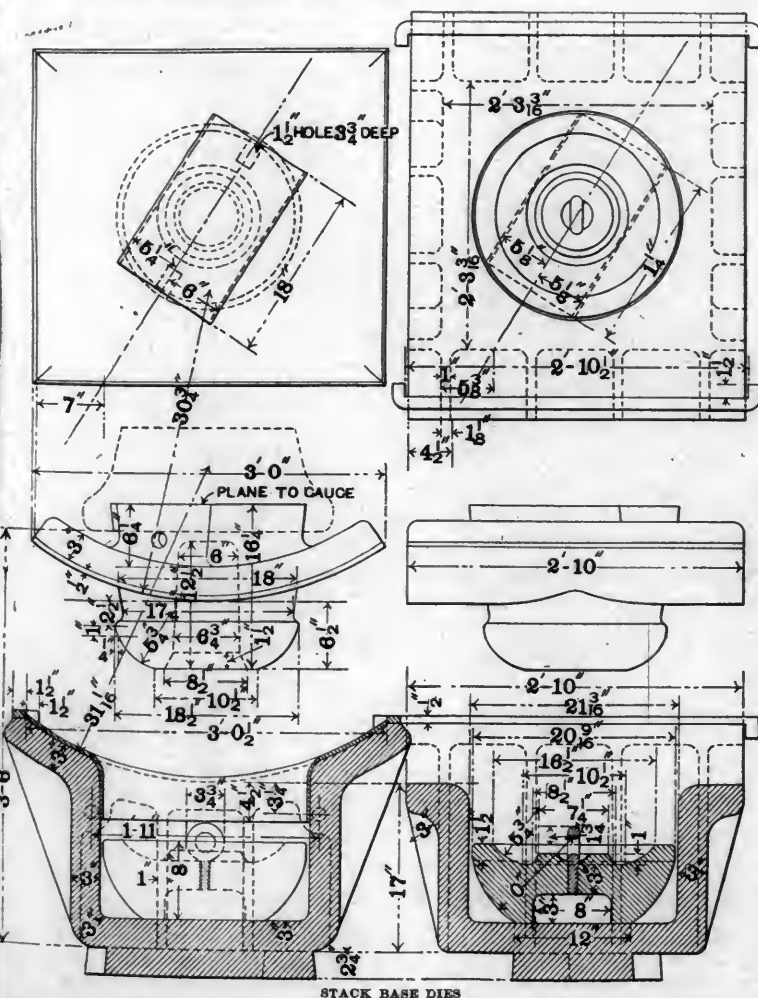


A SPRING VISE.

degree spindle. This rises and falls with the tool. On the vertical screw attached to the frame and which is clearly shown in the side and front elevations, there is, what might be called a friction rack. This can be raised and lowered by the vertical screw just alluded to and its position is such that the friction wheel runs into it on the rise, turns the 45-degree spindle and thus feeds the tool. As the friction contact is lowered the wheel moves over it for a greater distance and the feed is increased. As it is raised the feed is lessened, and it is stopped by slackening the frictional contact of the feed wheel.

Sleeping Car Rates.

As we announced in our last issue, agitation has been going on for some time looking to a reduction of sleeping car rates, and specially to a reduced rate for upper berths. About the best exposition of the folly of the plan are the following remarks on the subject recently made by an officer of the Wagner Palace Car Company. He said:



STACK BASE DIES

stack bases. As the dimensions are so fully given upon the engraving, any recapitulation of them is unnecessary.

An Air Hoist.

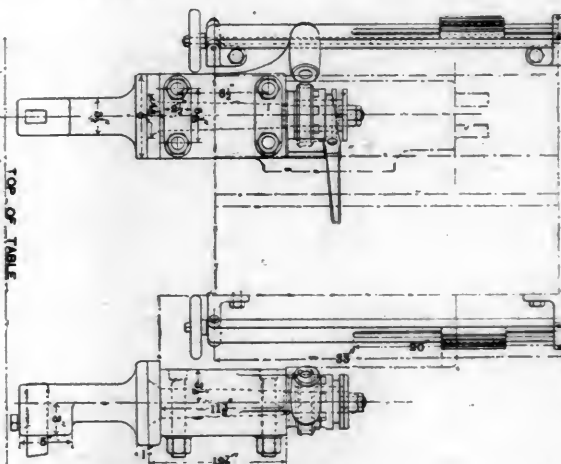
The hoist of which an engraving is here given is one that is in use in the West Albany shops of the New York Cen-

The whole is bolted to a 3-inch plank, having a passage-way cut out on one side for a 1/4-inch air pipe leading into the bottom of the cylinder from a three-way valve of simple construction, that has, on the inside, a screw connection for making the attachment to the main air-pipes running from the compressor.

A Spring Vise.

This is not a vise that is operated by a spring, but is designed to hold the leaves of plate springs while the band is being shrunk on. This is also in use in the Reading shops of the Philadelphia and Reading Railroad. Its construction as well as its

principal dimensions are clearly shown by the engravings. It consists of a strong frame that includes one jaw and is rigidly bolted to a heavy block set in the floor. The screw is two inches in diameter and is fixed while the movable jaw with its nut moves over it. This



ATTACHMENT FOR SLOTTING BOXES.

"I say unqualifiedly that the sole practical result in doing this would be a net reduction in our earnings of about 20 per cent. with no advantage to the railroad company operating our cars, and practically no advantage to the traveling public. The rate for an upper berth between New York and Boston is \$1, but the lower berths at \$1.50 are invariably sold first. We have sleeping car tickets on sale in the same offices where the Boston and New York tickets are sold, and agents inform me that passengers are just as anxious to secure lower berths in the New York cars at a higher price than is charged for the upper, as they are to procure the lower berths in our sleepers on runs where the price of the uppers and lowers is the same. I feel certain that any one who gives the subject careful consideration must be convinced that an attempt to establish first and second-class rates in a sleeping-car would not be successful, or appreciated by the traveling public. The ordinary traveling man is keen to secure a reduction in railroad rates that does not make a second-class passenger of him but the reduction in the price of upper berths would have, in my judgment, an entirely different effect. A passenger now buys an upper berth when the lowers are sold, on the basis of first come first served, and there is no question of caste, or first or second-class rates about the transaction. My experience warrants me in the belief that 99 passengers out of 100 would be in no way influenced by the fact of an upper berth being sold at a lower rate, while, on the contrary, I believe that in many cases it would absolutely deter passengers from buying upper berths, on the ground that they would not want to be regarded as going in for something cheaper than their neighbors in lower berths."

Kind of fuel to be used.....	18 luminous coal
Weight on drivers.....	78,000 lbs.
" truck wheels.....	47,000 lbs.
" total.....	125,000 lbs.
Wheel base, total, of engine.....	23 ft. 7 in.
" driving.....	8 ft. 6 in.
" total (engine and tender).....	47 ft. 6 in.
Height, center of boiler above rails.....	8 ft. 8 in.
" of stack.....	14 ft. 11 in.
Heating surface, firebox.....	159.3 sq. ft.
" tubes.....	1,715.6 sq. ft.
" firebrick tubes.....	28.8 sq. ft.
" total.....	1,854 sq. ft.
Graze area.....	26.96 sq. ft.
Drivers, diameter.....	75 in.
" material of centers.....	Cast steel
Truck wheels, diameter.....	36 in.
Journals, driving axle, size.....	8 in. dia. x 11 in. long
" truck.....	6 in. dia. x 11 in. long
Main crank pin, size, main rod $\frac{5}{16}$ in. & $\frac{5}{16}$ in.; side rod, $\frac{1}{4}$ in. dia. x 4 in. long.....	
Cylinders, diameter.....	19 in.
Piston, stroke.....	24 in.
" rod, diameter.....	34 in.
Kind of piston rod packing.....	Jerome malleable
Main rod, length center to center.....	7 ft. 7 $\frac{1}{2}$ in.
Steam ports, length.....	20 in.
" width.....	1 $\frac{1}{2}$ in.
Exhaust ports, length.....	20 in.
" width.....	20 in.
Bridge, width.....	15 in.

Kind of fuel to be used.....	Bituminous coal
Weight on trucks.....	83,000 lbs.
" " driving wheels.....	43,000 lbs.
" " total.....	126,000 lbs.
Wheel base, total, of engine.....	23 ft. 10 1/2 in.
" " driving.....	8 ft. 6 in.
Height, center of boiler above rails.....	8 ft. 6 1/2 in.

and the
inches,
here it
reased
point
Cast
ones,
to get
The
deck
ot put
done,
By
synd
emove
nd the
cab is
ed and
ed for

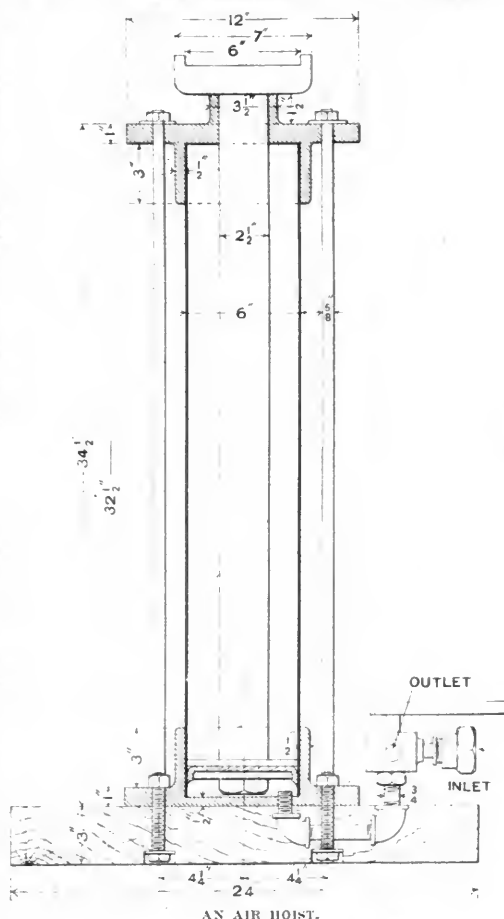
Valves, kind of.....	Allen-Richardson Balanced
" greatest travel.....	8 in.
" outside lap.....	1 1/4 in.
" inside clearance.....	1/4 in.
" lead.....	1/4 in. lap in full gear forward motion and back eccentric set to give 1/4 in. lead at 6 in. cut-off forward motion.
Boiler, type of.....	Extended wagon top
" working steam pressure.....	190 lbs.
" material in barrel.....	Carbon steel
" thickness of material in barrel.....	1/2 in.
" diameter of barrel at first ring.....	62 in.
Seams, kind of.....	Multiple riveted, butt with welt
" " circumferential.....	Inside and outside
Thickness of tube sheets.....	Double riveted
" of crown sheet.....	3/4 in.
" of flange sheet.....	3/4 in.
Crown sheet stayed with.....	Radial stays 1 in. diameter
Home, diameter.....	30 in.
Tubes, number.....	287
" material.....	Syracuse iron No. 11
" outside diameter.....	2 in.
" length over sheets.....	11 ft. 6 in.
Firebox, length.....	3 ft. 4 1/2 in.
" width.....	77 1/4 in.
" depth front.....	65 1/4 in.
" back.....	65 1/4 in.
" material.....	Shoenberger steel
" thickness of sheets.....	Back and sides, 1/2 in.
" brick arch? Yes.....	Supported on four 3 in. tubes
" water space, width.....	Front, 4 1/2 to 5 in.; sides, 1 to 4 1/2 in.; back, 4 in.
Grate, kind of.....	Rocking, with drop plate
Smokebox, diameter outside.....	65 in.
" length from flue sheet.....	69 1/2 in.
Exhaust nozzle, single or double.....	Single
" diameter.....	4 1/2 in., 5 in. and 5 1/2 in.
" distance of tip below center of boiler.....	1 1/2 in.
Netting, wire or plate.....	Perforated plate
" size of perforation.....	1/4 in. by 3/8 in.
Stack, straight or tapered.....	Cast iron taper
" least diameter.....	Near bottom, 14 in.
" greatest diameter.....	At top, 16 1/4 in.
" height above smokebox.....	3 ft. 6 1/4 in.

Special Shop Tools.

Stack Base Dies.

Among the many other special tools that have been made and are in use in the shops of the Philadelphia & Reading Railroad at Reading, Pa., are the dies that are used under the steam hammer for stamping out the bases for the smoke-stacks. The one illustrated is that used for stamping the bases for 20 inch stacks. It will be seen to consist of a cast-iron matrix finished to the curve and outside diameter of the base. This is keyed to the anvil, while the stamp is keyed to the hammer head as indicated by the center figure on the left. The process is exceedingly simple, the heated plate is put over the matrix, and the head coming down forces it into shape. It is the impression of many that hydraulic pressure is alone suited for this class of work, but it is a mistake. A wide range of stamping and pressing can best be done with the steam hammer. The Schoen Manufacturing Co., for example, stamp out all of its center plates under the hammer, and do it with a rapidity that could not be approached by the hydraulic press. The same statement holds good with regard to these

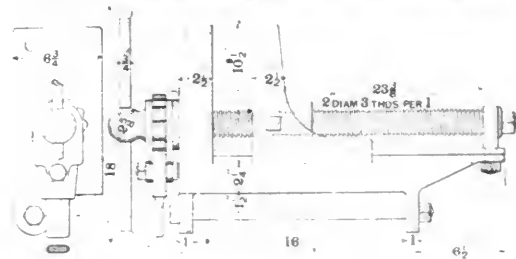
tral & Hudson River Railroad for raising driving-boxes in the jaws. It is formed of a piece of 6-inch brass tubing set in castings at each end, and which form the top and bottom. They are held together by four 1/2-inch bolts. The piston rod is a bar 2 1/2 inches in diameter with a 1/2-inch plate and a cup-packing bolted to the lower end. At the top there is a casting having a shape suitable for holding the boxes.



jaw can be rapidly run up by the hand lever in the usual way and the final tightening secured by the ratchet lever to which a long handle can be attached. It is simple, strong, cheap, rapid in action and home-made.

Attachment for Slotting Boxes.

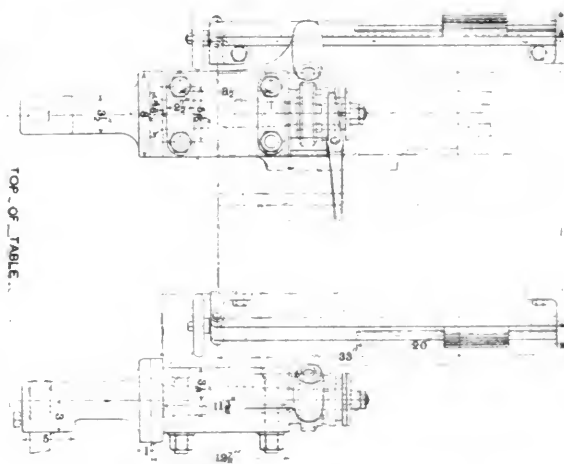
Here is another from the same Reading shops that are so rich in special contrivances. This is especially designed for slotting the curved face in driving-boxes, the tool is carried at the lower end of a spindle that is fitted, at the upper end, with a clutch engaging a worm gear. This worm gear meshes with a worm on the spindle shown in the plan as standing at an angle of 45 degrees with the center line of the machine. After the box is brought to a central position with the cutting spindle the tool can evidently be given a circular feed by turning a hand-wheel on the 45-degree spindle. The power feed is obtained by means of the grooved friction wheel on the 45-



degree spindle. This rises and falls with the tool. On the vertical screw attached to the frame and which is clearly shown in the side and front elevations, there is, what might be called a friction rack. This can be raised and lowered by the vertical screw just alluded to and its position is such that the friction wheel runs into it on the rise, turns the 45-degree spindle and thus feeds the tool. As the friction contact is lowered the wheel moves over it for a greater distance and the feed is increased. As it is raised the feed is lessened, and it is stopped by slackening the frictional contact of the feed wheel.

Sleeping Car Rates.

As we announced in our last issue, agitation has been going on for some time looking to a reduction of sleeping car rates, and specially to a reduced rate for upper berths. About the best exposition of the folly of the plan are the following remarks on the subject recently made by an officer of the Wagner Palace Car Company. He said:



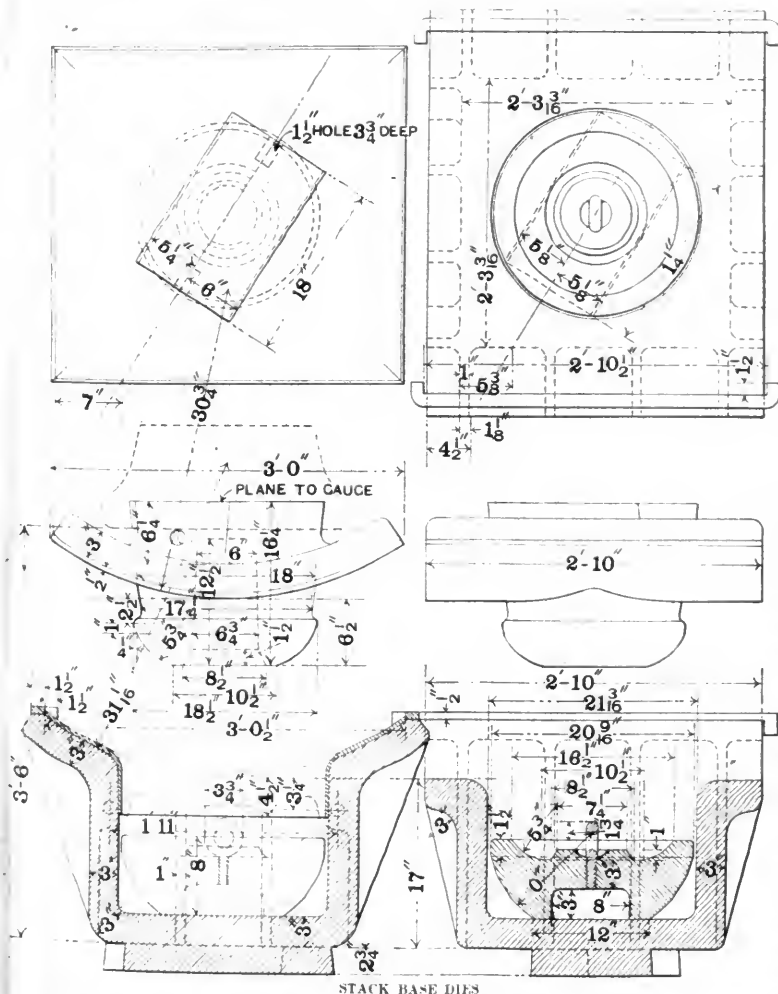
ATTACHMENT FOR SLOTTING BOXES.

"I say unqualifiedly that the sole practical result in doing this would be a net reduction in our earnings of about 20 per cent. with no advantage to the railroad company operating our cars, and practically no advantage to the traveling public. The rate for an upper berth between New York and Boston is \$1, but the lower berths at \$1.50 are invariably sold first. We have sleeping car tickets on sale in the same offices where the Boston and New York tickets are sold, and agents inform me that passengers are just as anxious to secure lower berths in the New York cars at a higher price than is charged for the upper, as they are to procure the lower berths in our sleepers on runs where the price of the uppers and lowers is the same. I feel certain that any one who gives the subject careful consideration must be convinced that an attempt to establish first and second class rates in a sleeping-car would not be successful, or appreciated by the traveling public. The ordinary traveling man is keen to secure a reduction in railroad rates that does not make a second-class passenger of him but the reduction in the price of upper berths would have, in my judgment, an entirely different effect. A passenger now buys an upper berth when the lowers are sold, on the basis of first come first served, and there is no question of caste, or first or second-class rates about the transaction. My experience warrants me in the belief that 90 passengers out of 100 would be in no way influenced by the fact of an upper berth being sold at a lower rate, while, on the contrary, I believe that in many cases it would absolutely deter passengers from buying upper berths, on the ground that they would not want to be regarded as going in for something cheaper than their neighbors in lower berths."

The whole is bolted to a 3-inch plank, having a passage-way cut out on one side for a 1/2-inch air pipe leading into the bottom of the cylinder from a three-way valve of simple construction, that has, on the inlet side, a screw connection for making the attachment to the main air-pipes running from the compressor.

A Spring Vise.

This is not a vise that is operated by a spring, but is designed to hold the leaves of plate springs while the band is being shrunk on. This is also in use in the Reading shops of the Philadelphia and Reading Railroad. Its construction as well as its principal dimensions are clearly shown by the engravings. It consists of a strong frame that includes one jaw and is rigidly bolted to a heavy block set in the floor. The screw is two inches in diameter and is fixed while the movable jaw with its nut moves over it. This



stack bases. As the dimensions are so fully given upon the engraving, any recapitulation of them is unnecessary.

An Air Hoist.

The hoist of which an engraving is here given is one that is in use in the West Albany shops of the New York Cen-

Campbell's Combination Freight Car.

In its last March issue, the NATIONAL CAR AND LOCOMOTIVE BUILDER published a brief general description of the combined stock, box and coal car designed in accordance with the suggestions of Mr. Robert B. Campbell, General Manager of the Baltimore & Ohio Railroad, and Mr. Howard Carlton, many of which are now in use on that road. We now present a more detailed description of this useful type of car than we then published, together with

stock traffic of the Baltimore & Ohio is very considerable, but it is nearly all an eastbound traffic. During the return trip to the West the cars are generally hauled empty, as they are unfitted for most kinds of westbound freight. Of course this haul is a dead loss, and it is to avoid such loss that this combination car has been designed. It can carry the eastbound live stock traffic most admirably, and it can carry all kinds of westbound traffic as well, whether it consists of merchandise, coal or coke, lumber, long or short, rails or grain. The advantages of such a car are so

The sides of the car are of an ordinary form of construction, as shown in Fig. 1. The figure 1 designates the vertical posts by which the sills, 29, and plates are joined; 2, diagonal braces; 3, shut posts; 4, shut braces; and 5, a belt rail. Hooked atraining rods are used in connection with these and constitute what is called a "bastard" Howe truss.

On the righthand side of the sectional view, (Fig. 4), a lining strip, 6, is shown, which is securely and permanently attached to the side frame posts, braces, and also to the

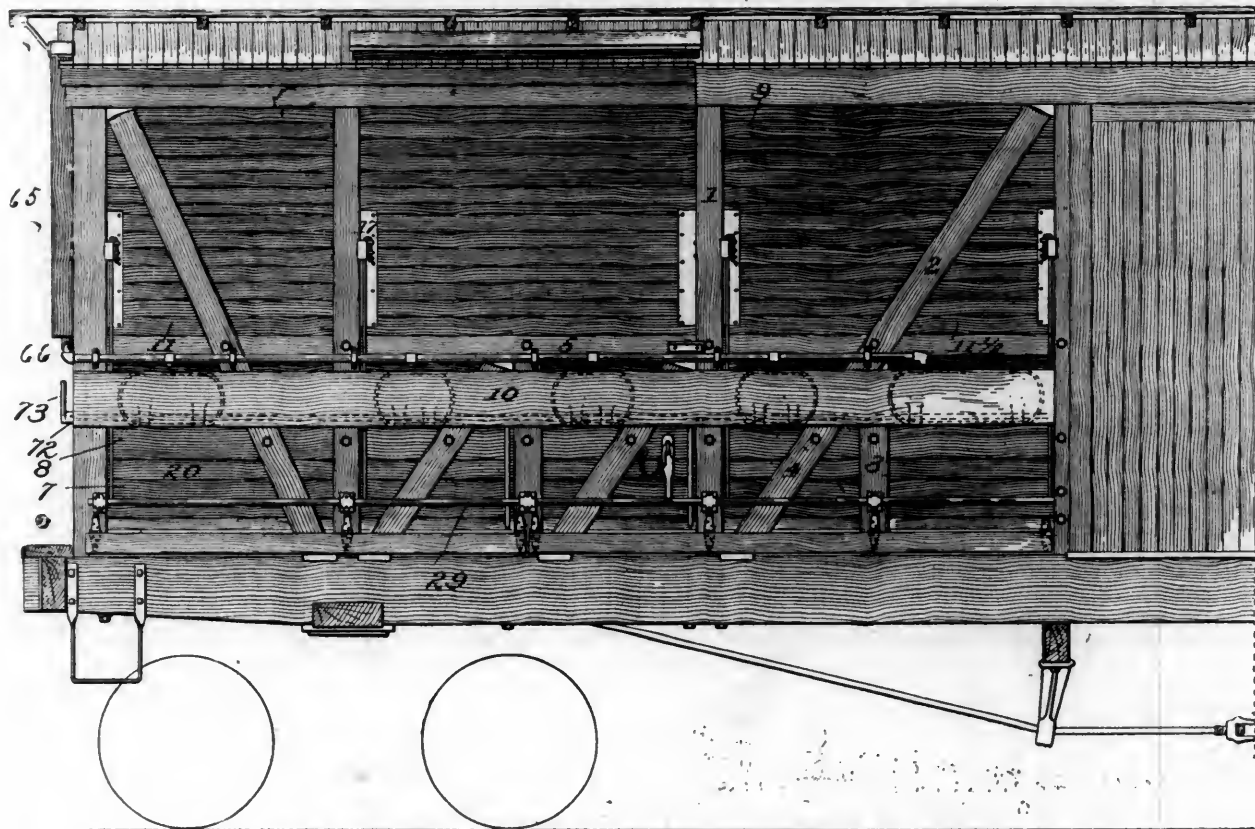


FIG. 1. HALF OUTSIDE VIEW OF CAMPBELL'S COMBINATION STOCK, BOX AND COAL CAR.

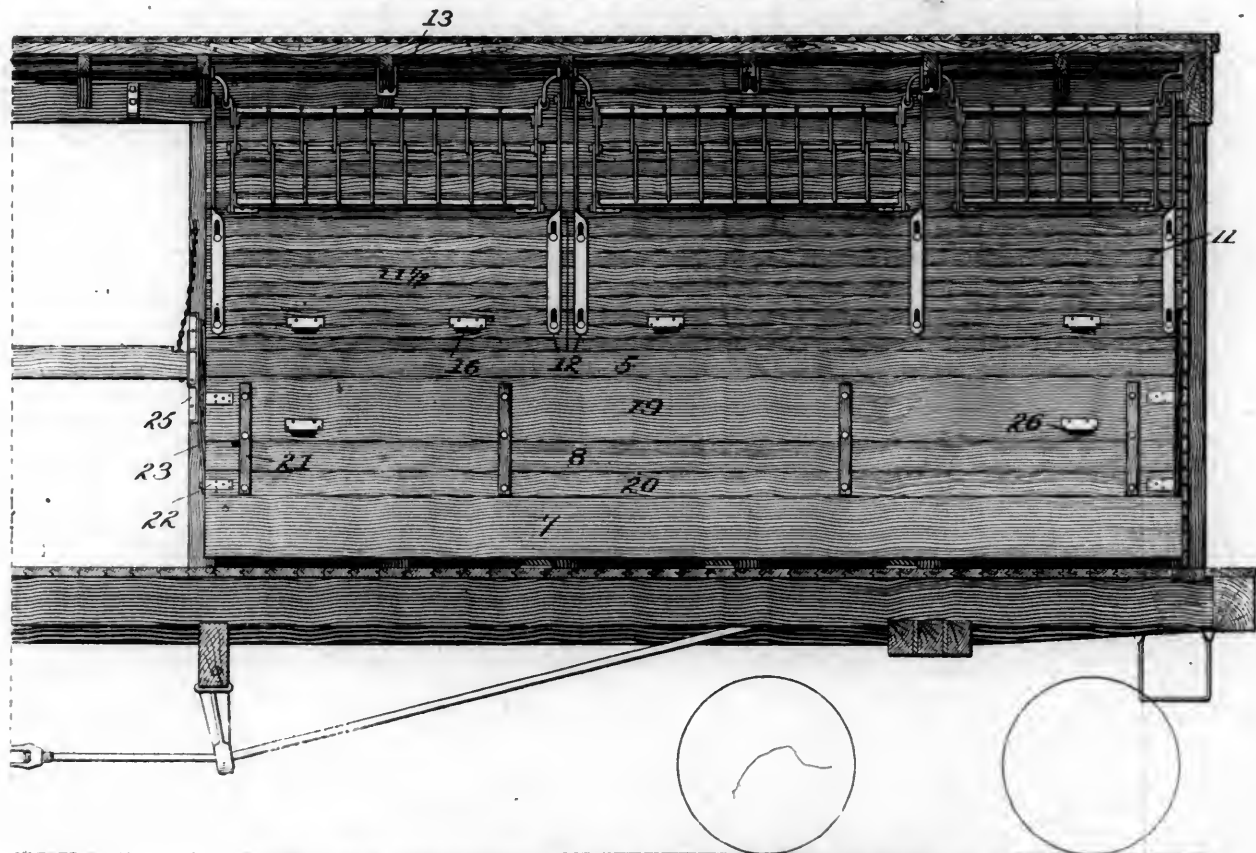


FIG. 2. HALF LONGITUDINAL SECTION, CAMPBELL'S COMBINATION CAR.

superior illustrations, which we are sure will prove of further interest to the readers of the NATIONAL CAR AND LOCOMOTIVE BUILDER while at the same time presenting much entirely new information to the readers of the AMERICAN ENGINEER AND RAILROAD JOURNAL, which papers are consolidated in this issue.

The main object sought in the construction of this type is to provide cars that can always carry a useful and paying load in which ever direction they run. The live

obvious that comment is unnecessary.

The mechanical construction of the car is such that it can be readily changed into the different classes of car, and is so constructed that it is strong and durable when used for any class of freight, and it is not an expensive car to keep in repair.

Fig. 1 is a view showing one-half of the outside of a car of this kind; Fig. 2, a longitudinal section; Fig. 3, an end view, and Fig. 4 a transverse section.

girth or belt rail 5; 7 is a lower longitudinal lining strip located several inches above the floor, and 8 an intermediate lining, both of which extend from the side door to the end of the car, and are permanently fastened to the posts and braces. An upper longitudinal-tongued and grooved lining, 9, covers approximately one-half the area of the space between the girth and pate, and is permanently secured to the posts and braces. What is called the "lower adjustable side," consists of two panels or slots, 1

onstruc-
the verti-
ned; 2,
and 5, a
nection
d" Howe
Fig. 4), a
nantly
to the

and 20, and is shown in its upper position on the right-hand side of Fig. 4. These slats are fastened together by iron cleats, 21. The edges of the slats and also those of the strips 6, 7 and 8 are made of an ogee form, so that they will engage with each other. This adjustable side is made removable, and can be fastened in the position in which it is shown on the right-hand side of Fig. 4, or it can be taken down and put in the position in which the slats 19 and 20 are shown on the left-hand side of Fig. 4. When it is in the former position, there are open spaces between the lining, 9, slats 19, 20, 6, 8 and 7, and the car is then adapted for carrying cattle.

If it was desirable to load it with coke or coal, the adjustable side 19 and 20 would be unfastened and removed from the position in which it is shown on the right of Fig. 4, and placed in that shown on the left side of the same figure, thus closing up the spaces between the slats 6, 8 and 7, and leaving that between the lining 9 and the belt rail open for loading the car. After it is loaded with this or other kinds of freight it is desirable to close this space. To do this, what are called the "upper adjustable sides" are provided. These consist of tongued and grooved paneling, 11, which is fastened to wrought-iron cleats or hangers, 12, which are pivotally connected to the rafters at *a*. By this means the paneling can be raised up against the roof, in the position shown on the right of Fig. 4, or when the slats, 19 and 20, are removed from their upper position it can be lowered into the position in which it is shown on the left of Fig. 4. It thus closes the opening

Pennsylvania Railroads.

Major Isaac B. Brown, Superintendent of the Bureau of Railways in the Department of Internal Affairs, of Pennsylvania, has prepared an interesting chapter for the forthcoming report of the Department, on the cost of railroads and equipment in that State.

An examination of the figures given shows that in the prosperous days of 1890, 1891 and 1892 there was a great increase made in the cost of roads and equipment. From 1890 to 1891 there were more than one hundred million dollars added to the cost of roads and equipment, and from 1891 to 1892, more than ninety millions. Here the tide changed and the annual percentage of increase in each of the three following years was very small compared with the years 1890 to 1891 and 1891 to 1892. From 1892 to 1893 the increase was about sixteen millions; from 1893 to 1894 about nineteen millions, and from 1894 to the close of the fiscal year, covered by this report, \$41,355,800.

There are eight great railway corporations whose cost of road equipment is given at more than \$50,000,000. These roads are the New York, Pennsylvania & Ohio, New York, Lake Erie & Western, Pennsylvania, Philadelphia & Reading, Pittsburgh, Cincinnati, Chicago & St. Louis, Lake Shore & Michigan Southern, Western New York & Pennsylvania, Pittsburg, Fort Wayne & Chicago.

From the figures given by these corporations it is found that the average cost of road and equipment per mile of road has been as follows:

ience, safety and comfort of its patrons. All these things have made the cost and equipment of the Pennsylvania road the high figure given above, but the security holders, the patrons and the citizens of Pennsylvania generally have the satisfaction of knowing that, although the cost has been enormously large, the "Pennsylvania" is acknowledged, both in Europe and America, to be the most perfect railway organization on the globe.

The extraordinary expenses that have made the Pennsylvania road cost so much per mile will apply in a great degree to other Pennsylvania companies. It cannot, however, be claimed that these causes have produced the high mileage cost of the New York, Pennsylvania & Ohio. Its line of road is through a territory where right of way was generally inexpensive, and it is but a single track line. It had no mountains to traverse, no great rivers to bridge, no expensive municipalities to deal with, and it certainly has never been burdened with expensive terminal facilities. Indeed it is hard to account for the high mileage cost of this road. The average cost of railways and equipment in the United States is not far from \$63,000 per mile. By comparison with the cost of roads in this section, it will be seen that there is a great disparity. There are some short line roads in Pennsylvania whose average cost per mile is much greater than that of the New York, Pennsylvania & Ohio. This is due in most cases to the great expense incurred in procuring rights of way, and also to the fact that but little or no part of the line is inexpensive, and there is therefore no chance of reducing the average. For

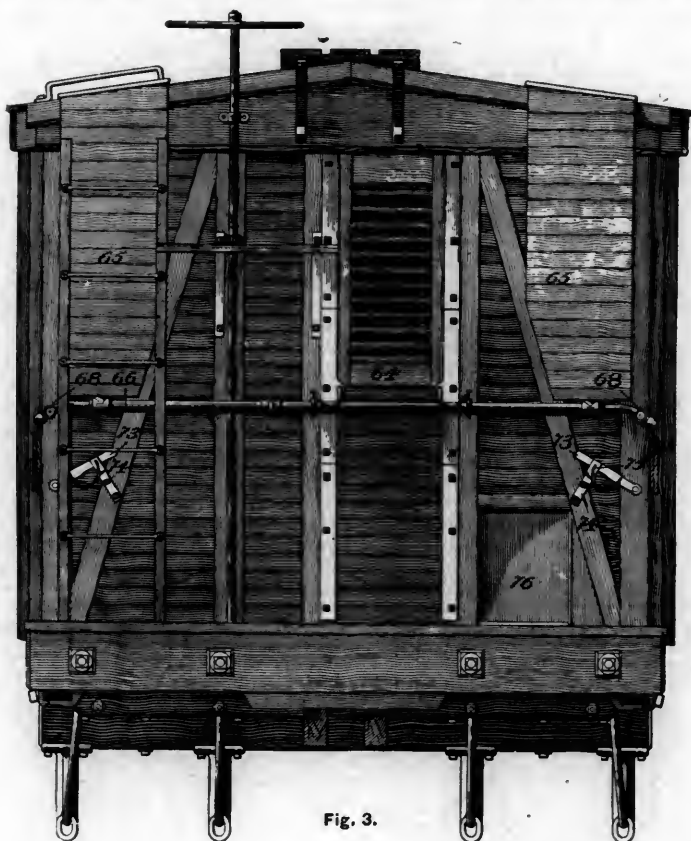


Fig. 3.

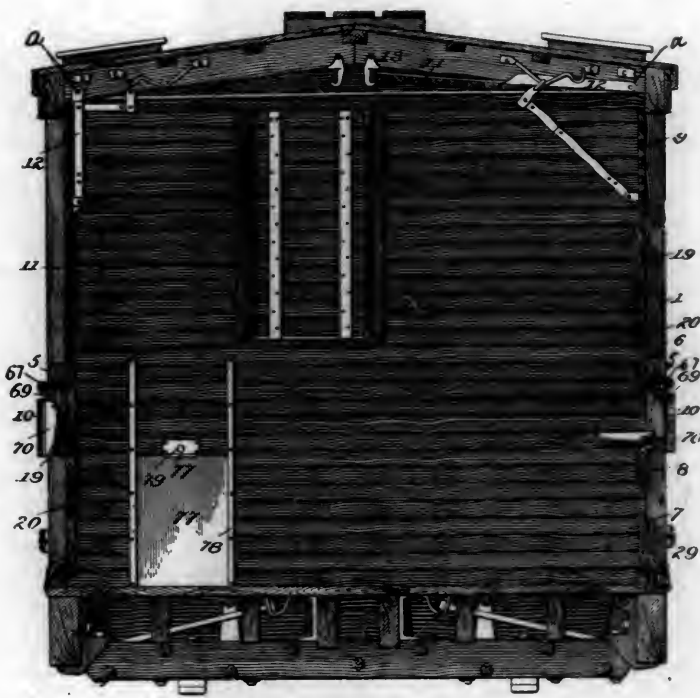


Fig. 4.

END VIEW AND TRANSVERSE SECTION, CAMPBELL'S COMBINATION FREIGHT CAR.

completely, and its ogee-shaped edges make a tight joint with the adjoining slats. It will be seen that when the lower adjustable side is in the position shown on the left of Fig. 4 the whole side of the car is closed, and is made watertight by means of the ogee edges of the slats, and it is thus adapted for carrying merchandise freight. A number of ingenious devices have been provided for making this transformation and fastening the different parts securely in their different positions.

For the transportation of cattle, hinged troughs, 70, are provided, which are attached to a longitudinal rod, 72, Fig. 1 which can be turned by a crank, 73, so as to bring the troughs into the position for use as shown on the right of Fig. 4, or they can be turned upward as represented on the left side of this same figure. For carrying a supply of water, tanks, 65, Figs. 1 and 3, are provided which are connected by suitable pipes so that water can be delivered to each of the troughs.

Iron hay racks shown in Figs. 2 and 4 are also placed in the upper part of the car near the roof, with doors in the latter for supplying the racks. Ventilating doors, 64, Fig. 4, are placed in the ends of the car and also small sliding doors, 76, at opposite oblique corners for loading steel rails, long timber, lumber, etc.

Such a car can be used in carrying one class of freight in one direction and another class in the opposite direction, thereby, it is evident, enabling the transportation companies to reduce the empty haulage of their cars to a minimum and to practically double the carrying capacity of their common freight cars.

New York, Pennsylvania & Ohio.....	\$395,988
Lake Shore & Michigan Southern.....	97,771
New York, Lake Erie & Western.....	302,596
Pennsylvania.....	213,705
Philadelphia & Reading.....	536,001
Pittsburg, Cincinnati, Chicago & St. Louis.....	85,891
Western New York & Pennsylvania.....	81,169
Pittsburg, Fort Wayne & Chicago.....	104,773

It is true that the railways of Pennsylvania have a greater capitalization, or show a greater cost per mile of road, than those of most other States, but there are cogent reasons for this apparent excessive cost. First, there is no State in the Union whose railways are so generally on the advance line of protection; and, second, there is no State in the Union where railway construction has been more expensive. Traversing and tunneling great mountains, bridging numerous and broad rivers, constructing double, triple and quadruple tracks, together with the expenditure of extraordinary amounts for the rights of way in rich farming regions and numerous municipalities, and the securing of the best terminal facilities, have made the railways of Pennsylvania show an exceedingly high rate of cost per mile of road.

No person conversant with the cost of railway equipment and railway construction can fail to observe the almost limitless cost of constructing and equipping the Pennsylvania Railroad. Its equipment is superb, and is always maintained in the most improved, substantial and perfect manner; its roadbed is perfect, and its stone and iron bridges are the best product of engineering skill. The design of the company seems to be to conserve the conven-

instance, the cost of construction alone of the Connecting Railroad is given as \$509,805; the Ohio Connecting, \$408,660; the Schuylkill River East Side, \$318,181.

The cost of the Philadelphia & Reading Terminal, which includes the expenditure for one of the most magnificent and expensive stations in the world, and for the right of way through the city of Philadelphia, is reported as \$7,926,031 per mile. This road is only a little over a mile in length. There are, however, only a few roads that have so high a degree of cost per mile.

An Extended Use of Copper.

Attention has often been called to the increase in the demand for copper, caused by the extension of electrical work in various directions. An instance of a new demand for the metal is found in the recently issued annual report of the Western Union Telegraph Company. The company, during the year ending with June last, added to its wire lines a net length of 11,859 miles, and over 10,000 miles of the new wire are of copper. The report states also that the company has adopted the policy of replacing all defective iron wires on its line with copper, the intention being to use that material alone on all the principal lines hereafter. The advantages of saving in weight, increased capacity for electrical transmission and diminished liability to interruption from atmospheric conditions are sufficient to make the copper wires more economical in the end, notwithstanding their greater first cost.

(Established 1832.)

AMERICAN ENGINEER

CAR BUILDER AND RAILROAD JOURNAL.

27TH YEAR.

65TH YEAR.

PUBLISHED MONTHLY

BY
R. M. VAN ARSDALE,

MORSE BUILDING.....NEW YORK.

GEORGE H. BAKER, Editor.

HERBERT W. POOL, Business Manager.

JANUARY, 1896.

Subscription.—\$7.00 a year for the United States and Canada; \$2.50 a year for Foreign Countries embraced in the Universal Postal Union.

EDITORIAL ANNOUNCEMENTS.

Advertisements.—Nothing will be inserted in this journal for pay, EXCEPT IN THE ADVERTISING PAGES. The reading pages will contain only such matter as we consider of interest to our readers.

Special Notice.—As the AMERICAN ENGINEER, CAR BUILDER AND RAILROAD JOURNAL is printed and ready for mailing on the last day of the month, correspondence, advertisements, etc., intended for insertion must be received not later than the 25th day of each month.

Contributions.—Articles relating to railway rolling stock construction and management and kindred topics, by those who are practically acquainted with these subjects, are specially desired. Also early notices of official changes, and additions of new equipment for the road or the shop, by purchase or construction.

To Subscribers.—The AMERICAN ENGINEER, CAR BUILDER AND RAILROAD JOURNAL is mailed regularly to every subscriber each month. Any subscriber who fails to receive his paper ought at once to notify the postmaster at the office of delivery, and in case the paper is not then obtained this office should be notified, so that the missing paper may be supplied. When a subscriber changes his address he ought to notify this office at once, so that the paper may be sent to the proper destination.

ANNOUNCEMENT OF CONSOLIDATION.

In the present number of this publication the NATIONAL CAR AND LOCOMOTIVE BUILDER has been consolidated with the AMERICAN ENGINEER AND RAILROAD JOURNAL, with the title of AMERICAN ENGINEER, CAR BUILDER AND RAILROAD JOURNAL. It will hereafter be published monthly under the editorial supervision of Mr. M. N. Forney, assisted by Mr. Waldo H. Marshall, heretofore editor of the *Railway Master Mechanic*, published in Chicago.

Mr. George H. Baker, who for the past four years has edited the NATIONAL CAR AND LOCOMOTIVE BUILDER, retires when this issue is mailed, and in doing so desires to express to each reader his appreciation of the support and courteous treatment he has uniformly received at the hands of the patrons of the paper. His thanks are specially due and are most sincerely tendered to the railroad officers in all parts of the country, who by their kindly help aided him in making the NATIONAL CAR AND LOCOMOTIVE BUILDER interesting and instructive to its readers. He came to the editorial chair from practical railroad work with high esteem for the sincerity, integrity and progressiveness of American railroad officers, and he retires with this sentiment strengthened and enhanced beyond question. No class of Americans excel in the possession, in high degree, of the first-named qualities, and the superior efficiency of American railroads and their equipment (especially their rolling equipment) to that of the railroads of the world, proves their progressiveness.

Sincerity and integrity of purpose are chief among the foundation principles of right living and of civilization. Progressiveness is the motor of civilization, conveying us always to better things in every walk of life. It is the spirit of Wordsworth's "Happy Warrior."

"Who, not content that former worth stands fast,
Looks forward, persevering to the last
From well to better—daily self surpassed."

It is the province of the technical railroad papers to promote this quality and herald its achievements; and in doing this they have done, and are doing, a work of incalculable advantage to railroad interests, to railroad men, and to the patrons of these leaders as well as servants of civilization. During its 26 years of existence the NATIONAL CAR AND LOCOMOTIVE BUILDER stood second to none in the quality and success of its efforts to fulfill its mission, within its scope, as indicated above; and during its last four years it was specially successful in promoting safer methods of passenger car construction, greater care of locomotive boilers, and the adoption of improvements looking to the more economical operating of locomotives.

REDUCING JOURNAL-BOX FRICTION.

The resistance of trains to being hauled constitutes the work that locomotives in overcoming it must perform. Any increase in this resistance is a tax upon locomotives, and any decrease in such resistance enables locomotives to perform more useful work (haul more cars or make better time) with the same expenditure of power. It is therefore evident that efforts to decrease train resistance are in the line of economy and greater efficiency. Train resistance is really made up of several "resistances," or it has several elements, such as the resistance of the air, the rolling friction of the wheels on the rails, journal-box friction and the inertia of the load. Probably the most susceptible to reduction of all these is journal-box friction. In cold weather this friction is greatly increased because of the viscosity of the congealed oil. We treated this matter at some length in the last (December, 1895) issue of the NATIONAL CAR AND LOCOMOTIVE BUILDER, and will not go into it again here further than to say that carefully conducted railroad laboratory tests have demonstrated that with a fall of temperature of 70 degrees the friction was doubled with the same oil. Dilution, preferably with kerosene, to a fluid consistency in actual service is the best remedy for this evil.

Our present purpose is to call attention to another possible means of reducing journal-box friction, and this is by giving to new axle-journals a smoother finish than is generally done before they are put in service. Persons familiar with the usual condition of new axle-journals know that they are much less smooth than journals that have seen some service. Actual service gives a smooth, high polish, the equal of which is not even attempted in most shops building new equipment or putting in "new wheels" beneath old equipment. In fact, it is commonly expected that new equipment will have hot axle-journals, and that "new wheels" in old equipment will "run hot." This is principally because of the commonly too rough surface of new journals. There are few more potent causes of train delays than "hot boxes," and in this connection the experience of the Missouri Pacific Railway should be valuable to every person interested in the most efficient operation of rolling equipment. As we announced a year ago, it is the practice of the mechanical department of this road to give a high polish to the journals of all axles and crank pins before they are put in service, and we then illustrated (NATIONAL CAR AND LOCOMOTIVE BUILDER, January, 1895, and described a tempered steel roller of cheap and simple construction used for burnishing the journals. This roller burnisher takes no metal from the journal, but compresses the surface about .002 of an inch, and imparts a harder and smoother finish, and higher gloss than we ever saw imparted by the longest and most successful service. On the road named this method has been found to give the *sine qua non* for avoiding hot boxes.

It may be assumed as true that the harder and smoother any two surfaces are, the less will be the amount of friction between them. Watchmakers know that fine steel pivots, running in highly polished holes cut in the hardest jewels, give rise to the least amount of friction, and consequently such surfaces are always chosen for fine watches, as the disturbance of the motion is thus reduced to a minimum. An apparent exception to this is found in the case of Babbitt metal, which is comparatively soft. We do not attempt to offer any explanation of this apparent exception to the general rule—for an exception it certainly is. In selecting the material for axle and crank-pin journals it is important that the material be hard and close-grained. Open-grained surfaces will begin to cut sooner or later, and when once this action fairly sets in it is almost impossible to stop it. Where wrought-iron is used, it is important that the fibers of the bar of which the axle is made be thoroughly welded together. If they be left in a loose and fibrous condition, and the direction of the motion be at right angles to the direction in which the fibers run, it will be impossible to produce a smooth-running journal.

One of the greatest benefits conferred upon mechanics by the modern improvements in the manufacture of steel and iron is the introduction of a hard, non-fibrous material for journals. Common steel, good enough for all purposes except the making of fine edge-tools, can now be had at a very moderate price, and wherever a journal is required to give the best satisfaction, it should be made of steel.

In finishing the surfaces of journals, great care ought to be taken to avoid the use of emery. It is wonderful how readily the hard-cutting grains of emery and similar polishing substances become imbedded in iron, brass and other materials, and then act just like diamond drills. Every watchmaker knows that a copper wheel or disk smeared with diamond-dust will rapidly cut the hardest steel, and the action is the same in regard to all metal surfaces to which emery has been applied with considerable force, as in the ordinary process of polishing. Smoothness is an essential requisite in all surfaces that slide or roll one upon the other, but this smoothness ought in all cases to be attained by burnishing in the manner described, or by cutting with sharp steel tools, and not by polishing with grinding substances.

PASSENGER TRAIN DETENTIONS.

If there is one thing that the average traveler appreciates more highly than anything else, even placing it above comfort and safety, to say nothing of the luxuries of the limited express, it is the certainty that the train upon which he is journeying will arrive at its destination on time. Perhaps this is valued more highly in this country than elsewhere on account of the rarity of its attainment; for when a railroad officer asserts, as was done at the New York Railroad Club the other evening, that the result of an investigation of carefully compiled statistics leads to the conclusion that upon a great trunk line, provided with every facility for the moving of its trains, 84 per cent. of them are late, the general public is apt to think that a much higher average prevails on the majority of roads, even though it may not quite touch the point given by one speaker, where, out of some 275 trains used by him on a certain road between April and January, only one was on time, and that one, to put it in the form of an Hibernianism, was a minute late.

But whether the average is thirty-four or one hundred per cent, it is very certain that the proportion of trains arriving at destination behind time is very much greater than it should be, and certainly so far as our own personal observation goes, is very much greater than it is in European countries. If this is so, then our Yankee smartness seems to be of no avail, for what does it really profit the country that we run one train the fastest in the world if the other ninety and nine drag along into the terminals at intervals of from one minute to four hours behind the schedule?

At the meeting of the New York Railroad Club already referred to, it was shown that less than 11 per cent. of the train detentions were due to failures of equipment, and that the remainder can be laid at the door of the operating department. But to the passenger it matters little whether the locomotive loses a crank pin or the dispatcher his wits, so long as the train fails to carry out the contract virtually made by the company when, by the publication of its timetable, it promises to the traveler on train 10 that he shall reach A at 10:30 a. m., but does not land him there until noon.

He knows that something is wrong, but what he cannot always determine. Personal observations and personal opinions are always liable to the error of the personal equation and must therefore be carefully weighed before being accepted; and with this preface it seems to us that the great majority of detentions which we have been able to sift to their sources may be referred to as caused either by an overloading of the locomotive or the interference of the freight trains that have blocked the way of the passenger trains. This means bad judgment and bad despatching. It is poor judgment to schedule a train at a speed so high that the locomotive can just make time when all conditions are favorable, and that a slight rain, a head wind, a little more slate in the coal, an excursion of slowly moving country people, or an extra car, will mean a steady loss of time from one end of the division to the other. Yet this is just what we do see in everyday railroad-ing. Roads running to competing points compete on time as well as rates, and from actual observation of accomplished facts we are led to the belief that, in some instances, the less favorably situated road, both with reference to motive power and profile of track, will crowd its through time down so as to meet the time of its competitor on paper, though the officers must know that they cannot fulfill their promises, and that their trains must run late.

Passengers will more readily take a train using 11 hours, on the timetable, to accomplish a certain journey if there is a certainty that 11 hours means 11 hours than they will a train taking 10 hours on paper with an equal certainty that that 10 hours means 10½, and it seems strange that railroad managers are so slow to appreciate this fact. Hence, if trains are overloaded there is but one remedy: apply more power. Either run two sections or double-head; but whatever it may cost, it will be found to pay to get there on time, and the moral of this first lesson is—do not overload the locomotive.

Regarding the second class of detentions, freight trains blocking the track, the first impression is that that means bad despatching, but as it is a general condition on almost every road in the country, whether it be single or double tracked, but especially in the case of the former, so, as the despatchers are men that, as a class, must rank above the average in intelligence and careful application and attention to business, we are led to inquire whether the duties of a despatcher are not beyond the limitations of the human mind to properly execute. When we know of despatchers issuing 300 orders in a trick of eight hours it appears that it is about time to shorten hours or change the system.

To change the system can mean but one thing and that is the scheduling of freight trains and instead of running them by telegraph, running them by timetable. Why not? The system has been tried and worked for years abroad and it would and should be more of a task to convince a European manager that the telegraph is the proper method of operating freight trains, than it would be to convert an American manager to the use of the schedule system. The one has the merit of success to recommend it. Passenger trains in France and Germany run on time and a careful observation of many hundreds of trains failed to find one that either arrived at destination or

passed intermediate stations behind time. This does not mean that trains are never late, but that one observer has totally failed to catch a train in the act, a condition that no one, in this country, would fail in if the investigations were prolonged through a single half day. With this apparent record at its back and the facts as well known as they seem to be, it seems strange that the system has no foothold in this country. We acknowledge that the work of the compilation of timetable on a single track road doing a heavy business would be immense, but when once done it is at least finished for the season, and the relief to the despatchers would be even greater. To issue 300 orders in eight hours, is to assume responsibilities that are too great to contemplate, and to run risks that come very close to being criminal, and when we consider the actual mental capacity of the average despatcher we are led to a suspicion that the limit of elasticity of his capabilities are very frequently exceeded.

The operating department, stands confessedly convicted of the responsibility for most detentions to passenger trains, and if the majority of those detentions are due, as we believe they are, to the overloading of engines and the interference of freight trains, it certainly does seem that it would be worth while from a business standpoint and for the advantages that would certainly follow the reputation of running trains on time, to make an application of the two remedies that we have indicated and which have worked so well and produced such markedly good results on foreign railroads.

The series of articles begun in this issue on the Construction and Maintenance of Railway Car Equipment will extend through several months, and will doubtless prove of much practical interest to those connected with the construction and repair of cars. The author of the articles is Mr. Oscar Antz, General Foreman of the car shops of the Lake Shore & Michigan Southern Railway at Cleveland, O. Mr. Antz is a member of the American Railway Master Mechanics' Association. He graduated at the Stevens Institute of Technology in 1878, and obtained considerable practical experience in the Meadows shops of the Pennsylvania Railroad, and worked through different grades, including the shop and drafting room. He was then made General Foreman of the South Amboy shops, which position he held for three years, and afterward was Assistant Master Mechanic of the Meadows shops for three years. From the latter position he resigned to become Division Master Mechanic of the Central Railroad of Georgia, which position he held for two years.

Proposed Michigan Central Bridge at Detroit.

The Michigan Central Railroad has decided to erect a high bridge of three spans to cross the river at Detroit that connects Lakes Erie and Huron, and a bill has been introduced in Congress to provide for its erection. The main channel spans to be not less than 1,100 feet in clear width between the masonry piers, of which there are to be only two, and the clear head-room for vessels under the spans is not to be less than 140 feet. The probable cost of the structure is estimated at \$4,000,000.

The Michigan Central has long enjoyed the reputation of being unsurpassed in its efforts to please its patrons. The decision to build this bridge is another illustration of this predominant spirit. The passage of the Detroit River by ferry has always caused considerable loss of time and unpleasant switching. A bridge will remedy this, and prove an added attraction for travelers for this already exceedingly pleasant route.

Oil Fuel in the Navy.

The recently issued report of the Bureau of Steam Engineering to the Secretary of the Navy states that:

"By reason of our ability to secure a large supply of this combustible, a series of experiments should be made with petroleum to find out its value for torpedo boats and the smaller types of vessels. In order to make these experiments of any value they would have to be long continued in order that the various burners might not only be tested for efficiency but also for endurance. One of the gunboats now building at Newport News would be an admirable vessel for testing the merits of liquid fuel. The tests should not only be progressive but they should be varied. One of the particular questions to be determined would be how much increased power over that furnished by natural draft could be secured by burning the liquid in conjunction with coal. Another important question that might be solved would be the effect of the various fuels on the ends of the tubes. It is safe to say that valuable aid would be rendered by those interested in the development of the oil industry, and an opportunity has now occurred when the value of liquid fuel for naval purposes can be definitely determined."

A Locomotive Water-Tube Boiler.

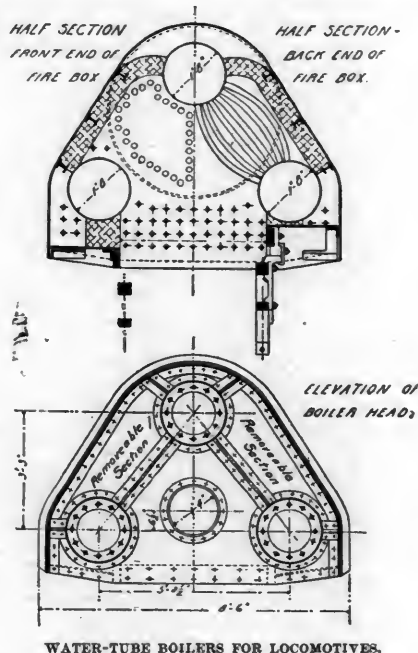
During the discussion of Mr. J. Snowden Bell's paper on Wide Fireboxes for Locomotives at the November meeting of the Western Railway Club, Mr. William Forsyth, Mechanical Engineer of the C. B. & Q. R. R., suggested the use of water tube boilers for locomotives to increase the pos-

sible heating surface without resorting to excessive boiler weight. The accompanying engraving reproduces drawings that show the proposed plan of such a boiler. In speaking of the matter Mr. Forsyth said:

"Mr. Bell says that in making boilers attention has principally been paid to enlarged heating surface, which is obtained largely through the tubes; the heating surface has not grown in proportion to the larger grate surface. In the Wooten boilers, which are so wide, the heating surface, to absorb the large amount to be burned on this grate, has not increased nearly as rapidly as the grate has increased. Now, in getting large capacity in a locomotive, we have, I think, nearly reached the limit to which we can go in a production of steam with these large boilers without enormously increasing the weight with the ordinary type of locomotive boiler."

"Recently Mr. Yarrow, in England, has built some torpedo boat destroyers, in which he has used water-tube boilers. In torpedo boats themselves he first used locomotive boilers, but when a speed service was required of 35 miles an hour he resorted to the use of a water-tube boiler; and they are also used in the various navies of the world where a large capacity is required in a compact space."

"It seems to me that in the development of locomotive boilers requiring much larger steam capacity, that a water-tube boiler might be made to be successful, and I have made a plan of something of that kind, in which I obtained a heating surface in the firebox of 579 square feet, which is from four to five times the heating surface in an ordinary locomotive firebox. In this design also there are no staybolts, except in the front leg, and the firebox can be made as the road limits will allow, so that, although that design



as it is may not be entirely practicable for locomotives, yet it meets the requirements of a large grate, of dispensing with staybolts almost entirely, and of providing an increase in heating surface much larger than the grate surface is increased."

Central Railway Club.

The next regular meeting of this Club to be held at the Hotel Iroquois, on Friday, Jan. 10, 1896, will be the annual meeting, at which officers will be elected for the ensuing year. The business session will be followed by a banquet in the evening. The tickets have been fixed at \$2 (including one lady), and can be obtained from the secretary, who should be advised not later than Jan. 5, how many seats are desired at the banquet.

The following reports will be considered:

"When Locomotive Boiler Tubes require to be safe ended should the safe end be welded to the tube proper with a lap weld or butt weld, and in what respect is one method preferable to the other? What would be the comparative cost of these two methods?" Committee: J. H. MOORE, J. N. WEAVER.

"Injury caused by the Drappings of Salt Water from Refrigerator Cars to Track Bolts, Trucks, etc." Committee: A. M. WAITT, Chairman; JOHN S. LENTZ, C. J. BUTLER.

Committee on Nominations: A. C. ROBSON, Chairman; LAMOTT AMES, E. A. MILLER, EUGENE CHAMBERLAIN, J. A. CHUBB.

Committee to Arrange Annual Banquet: F. B. GRIFFITH, Chairman; W. H. GARDNER, E. A. BENSON, O. P. LETCHWORTH, HARRY D. VOGHT.

Discussion will be had on the following:

Master Car Builders' Rules of Interchange, as revised at Pittsburg, by a committee composed of members of railroad clubs.

Topical questions submitted by members.

Exhibits at the Next Conventions.

The next conventions of the Master Car Builders' and Master Mechanics' Association will be held at Congress Hall, Saratoga Springs, N. Y., June 17th to 24th, inclusive.

It is the wish of the Joint Committee of the Associations that a very complete exhibition be made of all goods and devices used in their respective departments, particularly new and improved machinery, and especially air compressors, pneumatic lifts and tools. In order that such may be shown to the best advantage, it has been decided to furnish, free of charge to the exhibitor, steam, compressed air, and power, and it is very desirable that those intending to make an exhibit, apply for space as early as possible. The Standing Committee has contracted with Congress Hall for accommodations for supply men at following rates: Single room, \$3 per day; double room, one person, \$4 per day; double rooms, two persons each, \$3 per day.

Exhibitors may have space reserved by applying to W. C. Ford, Secretary of the Standing Committee of the Supply Men's Association, Room No. 19, No. 29 Broadway, New York City.

A President's Private Car.

A special car for the use of President Stuyvesant Fish, of the Illinois Central Railroad Company, was recently completed and put in service. The car is 69 feet 6 inches long over the sills, and 10 feet 4 inch wide. Hinson combination platforms are used. The windows have double shades, white outside and dark inside. The dining-room is arranged to accommodate 12 persons at the

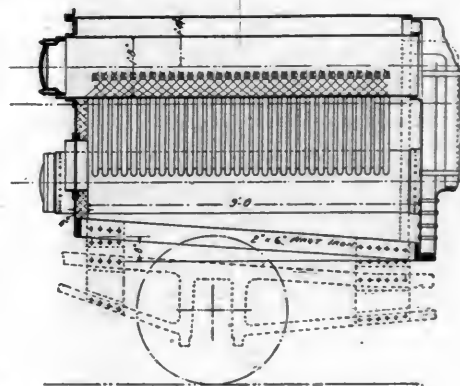


table. There are three staterooms, each with private toilet rooms and dressers, and two of them have upright folding beds.

The inside finish of the car is in polished mahogany except at the rear end, where quarter-sawn oak is used. It is lighted with Pintsch gas, and is also wired for electric lights, electric heating and electric fans. The closets are of the Campbell-House pattern. The washstands and water coolers are white metal, and hammered scrap axes are used, and the trucks have 38-inch Krupp steel-tire wheels.

The Fastest Regular Train.

The New Central & Hudson River Railroad increased the scheduled speed of its Empire State Express on Dec. 4 from an average of 51 miles an hour to 53.33 miles an hour between New York and Buffalo. For more than four years this train has made its daily run of 440 miles in 520 minutes, including four stops and 28 slow-downs. Its new time of 495 minutes is not that of an experimental run, but is scheduled for daily service between New York and Buffalo until a further reduction becomes practicable. The speed of the best trains of foreign nations is: England, 51.75 miles an hour; Germany, 51.35; France, 49.88; Belgium, 45.04; Holland, 44.73; Italy, 42.34; Austria-Hungary, 41.75. America now heads the list with 53.33 miles an hour to the credit of the Empire State Express.

The Pacific Cable Company.

A meeting was held in New York, Dec. 7, to complete the organization of the above-named company. It will lay a cable in the Pacific Ocean to connect San Francisco with the proposed American naval station at Pearl River Harbor, Sandwich Islands, and to Japan, China, Australia and India. It is understood that the contract relations between the Western Union Telegraph Company and the English Atlantic cables expressly provide that the Western Union Company is free to use a Pacific cable route with the countries named, but, aside from this fact, it is asserted, it will be in the interest of all the Atlantic cables to send their messages to the East via this Pacific cable, as it is estimated that more than 90 per cent. of the traffic is European. Thus the establishment of an American Pacific cable will attract to it a large traffic which is now diverted to other lines.

Personal.

Mr. E. C. Osborn has been appointed General Manager of the Poughkeepsie & Eastern.

Mr. A. L. Rives, General Superintendent of the Panama Railroad, has resigned.

Mr. Collis Shanks has resigned the position of General Foreman of the South California shops at Los Angeles, Cal.

Mr. W. E. Symons, Master Mechanic of the Atchison, Topeka & Santa Fe, at Raton, New Mexico, has resigned.

Mr. T. S. Inge has been appointed Master Mechanic of the new Burlington (N. C.) shops of the Southern Railway.

Mr. Charles F. Mayer, President of the Baltimore & Ohio Railroad, has resigned.

Mr. J. W. Karner has been appointed General Manager of the St. Louis, Belleville & Southern, with headquarters at St. Louis.

Mr. G. A. Miller, who has been Acting Master Mechanic of the Florida East Coast Railway, has been appointed to the position.

Mr. R. L. Herbert has been appointed Master Mechanic of the Southern Pacific at Victoria, Tex., vice Mr. I. R. Garnott, transferred.

Mr. Albert Griggs, Assistant Superintendent of Motive Power of the Chicago & Eastern Illinois Railroad, has resigned and the position has been abolished.

Mr. C. E. Schaff, Assistant General Manager of the Cleveland, Cincinnati, Chicago & St. Louis Railroad, has been appointed General Manager of the same.

Mr. George B. Roberts, President of the Pennsylvania Railroad, was on December 12 chosen Permanent Chairman of the Board of Control of the Joint Traffic Association.

Mr. A. D. Allibone has been appointed Purchasing Agent of the Wisconsin Central, with headquarters at Milwaukee, Wis., to take effect January 1, in place of Mr. J. A. Whaling, resigned.

Mr. J. R. Lane has been appointed Superintendent of the Macon & Birmingham, in charge of transportation, roadway and machinery department, with headquarters at Macon, Ga.

Mr. I. W. Fowle, who has been Master Mechanic of the first district of the Cincinnati, New Orleans & Texas Pacific, at Somerset, Ky., for about three years, has resigned to engage in other business.

The death of Mrs. Emiline Westinghouse has been announced. She was the mother of George Westinghouse, Jr., and H. H. Westinghouse. Mrs. Westinghouse was 86 years old.

Mr. W. C. Peterson has been appointed Foreman of the motive power and car departments of the International & Great Northern Railway, with headquarters at San Antonio, Tex.

Mr. E. P. Bryan has been appointed General Manager of the Terminal Railroad Association of St. Louis, succeeding Mr. Joseph Ramsey, Jr., who has become General Manager of the Wabash Railroad.

Mr. Philip Campbell, General Manager of the Birmingham, Sheffield & Tennessee River road in Northern Alabama, has resigned. His successor is Mr. Samuel Hunt, General Manager of the Cincinnati, Portsmouth and Virginia.

Mr. T. W. Adams, formerly foreman of car repairs of the Boston shops of the Boston & Albany Railroad, and a son of Mr. F. D. Adams, of that road, has been appointed Master Car Builder of the New England Railroad, with headquarters at Norwood, Mass.

Mr. E. H. Talbot has been appointed the Eastern representative of the *Railway Age* and *Northwestern Railroader*. He will be assisted by Mr. W. C. Ford, who for three years has represented the paper in the East. Mr. Talbot was the founder of the *Railway Age*, and was its President for 15 years.

Mr. Patrick Sterling, Locomotive Superintendent of the Great Northern Railway of England, died at Doncaster, England, November 11, aged 75 years. The vacancy has been filled by the appointment of Mr. H. A. Ivatt, formerly Locomotive Engineer of the Great Southern & Western Railway of England.

Mr. Richard Durborow has been promoted to be Master Mechanic of the West Philadelphia shops of the Pennsylvania, vice M. Garrett, retired, and R. H. Garland has been promoted from General Car Inspector, with headquarters at Altoona, to be Assistant General Foreman of the West Philadelphia shops, succeeding Mr. Durborow.

Mr. P. H. Schreiber, who has been Master Mechanic of the second district of the Cincinnati, New Orleans & Texas Pacific for the past six years at Chattanooga, Tenn., has had his jurisdiction extended over the entire Chattanooga division, with charge of the Somerset shops in connection with those at Chattanooga. His headquarters will be at Chattanooga, as heretofore.

Mr. William Apps, formerly Master Car Builder of the Illinois Central, has been appointed General Master Car Builder of the Canadian Pacific at Montreal. He succeeds Mr. John Higginson, who recently resigned. Mr. Apps was formerly in charge of the car department of the Great Northern. He was afterward Master Car Builder of the Western of Alabama, and has also been with the Chicago & Eastern Illinois, and the Illinois Central.

On Jan. 1st Mr. Chas. M. Hays assumes the duties of General Manager of the Grand Trunk Railway, to which position he was appointed some months ago, succeeding Mr. L. J. Seargeant, who retires from the management of the road to act in an advisory capacity to the Board of Directors in London. Mr. Hays is an able manager, and his friends expect that he will make a record on the Grand Trunk which will be creditable to himself and exceedingly satisfactory to the owners and patrons of the road.

Mr. William F. Merrill, General Manager of the Chicago, Burlington & Quincy Railroad, has resigned to become Second Vice-President of the Erie Railway in charge of the operating department. Mr. Merrill has been General Manager of the C., B. & Q. since 1890, succeeding Mr. E. P. Ripley. He was born in 1843, at Montague, Mass., and began railroad service in 1866, and was employed as a civil engineer on several Western roads until 1880, when he became a Division Superintendent on the Wabash. Two years later he went to the Chicago & Alton as General Superintendent, and a year later he became Superintendent of the Iowa lines of the C., B. & Q., and four years later General Manager of the Hannibal & St. Joseph and the Kansas City, St. Joseph & Council Bluffs railroads, which form a part of the Burlington system. He occupied this position until he was promoted in 1890 to be General Manager of the C., B. & Q. proper. It is announced that he is to be succeeded by Mr. W. C. Brown, who has been General Manager of the H. & St. J. and the K. C., St. J. & C. B. roads since 1890.

The Greatest Auction Sale.

The world's greatest auction sale occurred at Topeka, Kan., on December 10, when the vast property of the Atchison, Topeka & Santa Fe Railroad Company was sold to Messrs. Edward King, Charles C. Beaman and Victor Morawetz, representatives of the Reorganization Committee. The reading of the notice of sale occupied 30 minutes. This done, Judge Johnson said that, in pursuance of the notice of sale just read, he offered the property to the highest bidder.

"What am I offered?" the auctioneer asked. "I offer \$60,000,000," said Edward King, in a low voice. "Do I hear any more bids?" cried Judge Johnson. "Once twice, the last call. The property is sold to Edward King, Charles C. Beaman and Victor Morawetz."

This ended the greatest auction sale ever known, and the crowd dispersed to the Federal Building, where Judge Caldwell held a session of court to confirm the sale.

As indicating the immensity of the sale it may be stated that the system proper embraces 4,670 miles of railroad, on which are now being used 864 locomotives, 28,187 freight cars, and 584 passenger cars. The system has practically been built within the past twenty years, the extension into Chicago being only about seven years old. Originally the line was intended to parallel the old Santa Fe trail, over which was transported the greater part of the commerce of the plains. Over 100 days were required to reach Santa Fe by freighters over this historic trail, the same route now being covered in twenty-eight hours by the road's overland trains. This commerce of the plains grew to such proportions that in 1858 there were on the trail 2,500 men in some way engaged in this traffic. In that year there were registered at Council Grove, Kan., 1,827 wagons, 429 horses, 5,316 mules, 15,714 oxen, and 67 carriages or passenger vehicles. During that year there were 9,608 tons of freight carried over the route, equal to about 500 carloads. There was over \$2,500,000 directly invested in this business, with another \$1,000,000 as an incidental investment. The trail started from Fort Leavenworth and from Independence Landing, formed a junction just below Lawrence, struck the Arkansas near where Great Bend is now situated, following the river 100 miles crossed and passed through the sandy country for about 60 miles to the Cimarron, which stream it followed to near the southwest corner of Kansas, thence in a general southwesterly direction to Santa Fe, 780 miles from Independence Landing. The present line of the Santa Fe follows practically the same route of the trail. Great opposition was made by the freighters to the building of the line.

The history of the management of the company since it was first organized has been a most varied one, and so many bright railroad officials have stepped to its head with great reputations as managers and had to retire beaten and oftentimes with discredit to themselves that the road has come to be known in railroad circles as a "man killer." In President E. P. Ripley, however, and Vice-Presidents D. B. Robinson and Paul Morton, an exceedingly able group of practical and progressive railroad men is now placed in control of this largest railroad in the world, and it is the confident expectation of those who know their ability and the resources of the road that the troubles of this great company are near an end.

Burglar Proof Express Cars.

A good deal has been said of late regarding the construction of so-called burglar-proof express cars for service on some of the railroads. The reports were to the effect that these new cars were to be made of steel with no windows or doors, or end platforms, and that they would be "collision proof." The President of the Adams Express Company, Col. L. C. Weir, in talking of the matter recently, said:

"It is all nonsense. We have cars equipped with burglar-proof and fireproof safes. These are strapped to the floor of the car, and they are as smooth as a baby's cheek. There isn't a crack where train robbers could possibly insert powder. When a train is attacked, and the robbers place a revolver under the nose of the messenger, he simply tells them: 'All right, boys, help yourselves. There is the safe; I can't open it.' And that stumps them. Whenever a robbery is reported, we are deluged with letters from all sorts of cranks and inventors over the country, each one of whom has a patent that is the only preventive. Only a short time ago we had one letter from a chap who wished us to keep what he had to offer an inviolable secret. He said that he had not patented it, and was only waiting to hear from us. His plan called for the construction under the roof of the car of a chamber with falling doors. As soon as the robbers entered the car, all the messenger had to do was to throw a switch. This let down the doors of the concealed chamber. As soon as the doors fell, a blast of air was created from some mysterious source, and countless numbers of little balls of India ink would be thrown into the car, branding every man jack of the robbers indelibly for future identification, to say nothing of scaring them to death."

"Another chap I remember had a scheme that was unique. It consisted of the placing of a cylinder in the car. The moment the messenger appreciated that he was attacked all he had to do was to drag the safes into the cylinder and lock them up there alone with himself. The cylinder was punctured with holes, which commanded every part of the car, and through them he could shoot the robbers down one by one. When we asked him what was the matter with the robbers shooting back through these same holes and puncturing the messenger, they were stumped and retired. On some of the Western roads they are now trying a new plan. Each express car is equipped with one or more cylinders of small diameter, which are filled with a powerful chemical preparation. The instant the messenger inside has reason to think that his car is threatened he takes the cylinder down from its case and drops it through a prepared opening in the floor of his car. Then, by a pressure of the foot or some other simple method, he ignites the thing. The chemicals flame out and illuminate the country for a great distance around. The cylinder becomes a great torch. The experiment is being tried there, but whether it will be a success or not remains to be seen."

So far as this company is concerned, there is not at the present time a single man out of durance vile who ever robbed the company; that is, unless his term has expired. This is true from the days of the Reno gang, and that was more than 30 years ago. It costs money to round them up, but we never let up in the search."

The Car Builders' Demand.

One of the most marked features of the lumber trade this year has been the steady, large and imperative demand from railroad companies and car shops for car building material. The panic of 1893 and the resulting depression in general business largely stopped the requirement for car and other railroad material. About the only buyers were roads in the hands of receivers, which were able to devote part of the earnings to the maintenance of way which supposed to be solvent roads devoted to the paying of interest. The result was that a year ago and in a more marked degree in 1894 side tracks and freight yards were encumbered with disabled equipment which was not immediately needed, and for the repair of which there were no available or appropriated funds.

In the midst of such a condition of things came a revival in business, a revival which, without much of the boom element in it, nevertheless was substantial and large. Repair work was taken up with vigor, and as the year progressed it was evident that new equipment was needed. Consequently the car shops have been crowded with work both on repairs and new construction, with a marked influence on the lumber trade.

The remark has been made that the salvation of the lumberman of Georgia has been the demand for car material. The fir manufacturers of Oregon and Washington have largely benefited, and in every line of the lumber trade the freight car requirement has given business and profit. This has been so even in the white pine trade and is one of the most cheerful features of the winter season, for the car demand has not yet abated in any marked degree.

In the wholesale markets like Chicago, the quietude of later December and early January is enlivened by an overhauling of the yards in getting out car lining and other similar stock. A common board or strip may have at one end four or five feet which is just what the car builder wants; and when otherwise the yard crews have little to do, they are taking down piles and remanufacturing the lumber in them so as to get better results in the aggregate than could otherwise be the case. The 175,000 miles of railroad in the United States with their requirement for ties, bridges, fencing, stations and cars furnish a no inconsiderable proportion of the lumber requirement of the country.—*The Timberman*.

The Most Advantageous Dimensions for Locomotive Exhaust-pipes and Smoke-stacks.

BY INSPECTOR TROSKE.

[Previous to the consolidation of the NATIONAL CAR AND LOCOMOTIVE BUILDER with the AMERICAN ENGINEER AND RAILROAD JOURNAL three portions of a translation of Herr Troske's very valuable paper, were published in the last-named journal. If succeeding portions were continued serially in the new publication, the readers of the NATIONAL CAR AND LOCOMOTIVE BUILDER would have been without these first parts. It has, therefore, been thought best to republish them in the consolidated journal.]

It is well known that the efficiency of a locomotive depends more upon the steaming qualities of its boiler than it does upon the proper dimensions being given to its principal parts and the adhesive weight that may be upon its wheels, and that this steaming quality is, in turn, dependent upon the combustion taking place upon the grate, and that this is finally dependent upon the strength of the draft. If this latter is too weak, the fire burns sluggishly and the steam production is low; while, on the other hand, if it is too strong there will be many pieces of unburned coal drawn through the flues, which will accumulate in the smokebox as cinders, oftentimes even blocking up that space, or a portion [will be thrown out of the stack as sparks; either case serving to increase the coal consumption unnecessarily. The draft may even be so violent, as a result of improper dimensions being given to the exhaust-pipe and the smoke stack, that in many locomotives it will be found that the fire no longer rests quietly upon the grates, but dances up and down upon them; which not only has the evil effect of increasing the consumption of coal by a very appreciable amount, but admits more cold air through the air spaces into the firebox than is actually needed for maintaining combustion. This excess of air lowers the temperature in the fire-box and the tubes, and as a consequence injures the production of steam. By contracting or enlarging the mouth of the exhaust-pipe, we know that we can easily increase or weaken the draft, but there are well-defined limits in both of these directions. Contraction goes hand in hand with an injurious back pressure upon the piston, resulting in just so much work lost by the locomotive; while an increase in the diameter of the pipe causes a lessening of the vacuum in the smokebox and firebox, so that finally the equalizing reserve action of the exhaust disappears, and the four exhausts for each revolution of the driving wheels are always sharply defined from each other, the steam, instead, as is the case when running at high speeds, of approaching continuity, now issues from the stack under separate impulses, and thus no longer acts uniformly upon the fire, but in a jerky manner. These are, therefore, the outlying limits to good and economical consumption of coal.

Furthermore, we are dependent, not only upon the proper size of the exhaust nozzle, but also upon its position below the bottom of the stack opening, and upon the dimensions of the stack itself—that is, upon its diameter, height, and position. These four dimensions have no less influence upon the action of the fire and the generation of steam than the exhaust nozzle itself. As with the exhaust nozzle, so by enlarging or diminishing the size of the stack, the draft may be lessened or increased, also by shortening or lengthening the same and finally by raising or lowering the exhaust nozzle with reference to the stack.

HISTORICAL SKETCH.

Soon after the construction of the first railway, experiments were instituted for the purpose of locating the exhaust nozzle in the most efficient position, and it is well known that Stephenson owes his victory in the locomotive contest at Rainhill, in 1825, to the fact that he was the first to make an application of the exhaust nozzles to boilers for inducing a greater draft. Pambour, in 1836, was the first to institute a systematic series of experiments. He made, however, only a few, and the results that he obtained are of no great value. Nevertheless Pambour set forth the proposition that the exhaust-pipe pressure varies directly as the speed of the piston and the generation of steam per hour, and, therefore, inversely to the sectional area of the pipe itself. He considered that the pressure in the exhaust-pipe was the same as the back pressure upon the pistons, until, in 1847, it was proven by Gouin and Le Chatelier that this is not the case. Among the French engineers who busied themselves with this question at that time was Polonceau. He made some special experiments with exhaust nozzles of various sizes.

Clark first threw light on these subtle relationships by means of his very important and thorough investigations which were made in 1850. They were made upon a large number of locomotives, and from them the following results were obtained:

1. The vacuum in the smoke-box stands in direct relationship to the pressure in the exhaust-pipe. That is, the vacuum expressed in inches of a water column gives the pressure in the exhaust-pipe in inches of mercury:

$$\frac{\text{Vacuum in smoke-box}}{\text{pressure in exhaust-pipe}} = \frac{1}{13.6}$$

or, in round numbers, $\frac{1}{14}$.

2. The draft creating properties of the exhaust is, first of all, dependent upon the form and size of the stack and the position of the nozzle. Above does the height of the exhaust opening and the diameter of the stack influence this matter.

3. With each stack there is some maximum size of exhaust nozzle that will produce the best results. For a given boiler there is only one diameter of stack that is most efficient; and for all other diameters the nozzle must be contracted.

4. The best position for the exhaust nozzle is that from which the steam will be blown vertically into the stack.

Hence the center line of the nozzle must coincide exactly with that of the stack.

5. The products of combustion must be able to enter the stack easily, either by making the bottom bell-shaped, or, better still, by locating the exhaust opening below the top of the smokebox by about the diameter of the stack.

The exhaust will thus be always blown through and through the products of combustion, and not merely over the top of the same. A straight, vertical exhaust pipe is therefore greatly to be preferred to the crooked pipe that was formerly in general use, since it offers less resistance to the steam as well as to the gases in their passage to the stack.

6. The proper sectional area of the exhaust nozzle is dependent upon the grate area, the sectional area of the tubes, the diameter of the stack, and the size of the smokebox:

The larger grate area and the sectional area of the tubes in the firebox tube-sheet, and the smaller the diameter of the stack and the size of the smokebox, the larger it is possible to make the nozzle.

7. In order that a stack may work at its maximum efficiency, it must have a length that is approximately about four times its diameter.

8. The smallest sectional area of stack that was observed was one-fifteenth of the grate area, and this permitted the use of a larger exhaust nozzle than any other larger stack. So that these observations are taken to indicate that this proportion (one-fifteenth) is the most efficient.

9. The exhaust nozzle may have a sectional area equal to from one-sixty-sixth to one-ninetieth of the grate area, provided that the sectional area of the tubes in the firebox tube-sheet shall be made from one-fifth to one-tenth of the grate area.

10. The vacuum in the firebox is from one-third to one-half of that in the smokebox.

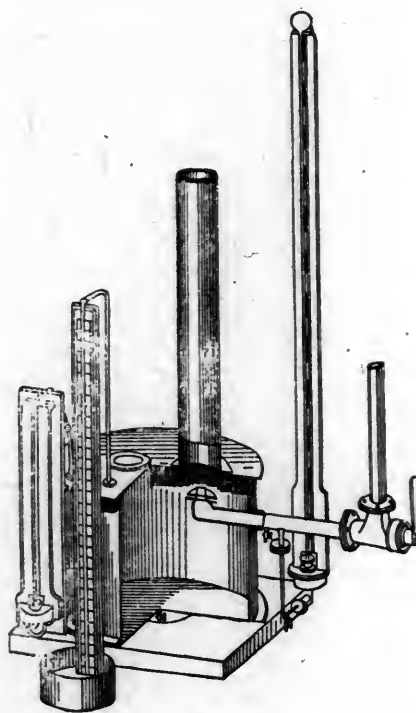


FIG. 1

(THE ZEUNER APPARATUS.)

It should be remarked just here that the English locomotives of those days had very small grates, whose area did not average more than 12 square feet; hence, Rules 9 and 10 cannot be applied to locomotives of the present day. Also, Rule 3 and the second paragraph of Rule 6, in which it is stated that the exhaust nozzle can be enlarged as the diameter of the stack is made smaller, cannot be applied in its general construction to locomotives. According to the Hanover experiments, the vacuum can be increased by making the diameter of the stack less. With this, if the original vacuum is to be retained, the nozzle may be enlarged, which will result in the lowering of the pressure in the exhaust-pipe, and the back pressure upon the piston; but, as I stated at the opening of this paper, this enlargement of the nozzle must take place between narrow limits, else the combustion will be poor and the coal consumption increased. For this reason, then, it would be inexpedient to use that small size of stack that would permit the largest nozzle to be used.

Furthermore, my investigations have led me to the belief that it is generally desirable to use as large a stack as possible. Especially worthy of note in the Clark rules that are given above are the results 2 and 5, wherein it is asserted that the height of the nozzle has an important influence upon the action of the fire, a position that is disputed as being incorrect by some later writers. Later, during Peacock's experiments, Clark was Locomotive Superintendent of the Manchester, Sheffield & Lincolnshire Railway, and in the summer of 1850 undertook a series of experiments with locomotives, and found that by lowering the opening of the exhaust-pipe and enlarging the same he could secure a better production of steam.

In the locomotive under consideration, which had a cylindrical stack with a diameter of 18 inches and having originally a nozzle $4\frac{1}{2}$ inches in diameter that was 1 inch above the top of

the smokebox, it was gradually dropped until it was 18 inches below the top of the smokebox, where a nozzle with an opening of $4\frac{1}{2}$ inches gave the best results. As a result of this experiment Peacock placed all of his nozzles at this distance below the top of the smokebox.

In Germany, Switzerland, and other countries these results seem to have been followed without any change up to the present time.

Zeuner.—Eight years after these experiments, in the summer of 1853, Zeuner began his well-known experiments upon the exhaust pipe, which he continued during the following year, and in 1853 published his epoch-making book, "The Locomotive Exhaust-Pipe," and embraced therein his theory of its action.

Zeuner carried on his experiments in the workshops of the Zurich Railway with an especial apparatus. In order to render a comparison possible between the results obtained by various experimenters, who have made use of special apparatus, and determine the value of their deductions, it will be well to give a short description of them.

The Zeuner apparatus is shown in Fig. 1. It consists essentially of a sheet iron chamber having a diameter of 22.44 inches and a height of 17.7 inches, into which the steam-pipe from the boiler projected carrying the blast nozzle at its extremity. Upon the top of this chamber the stack was placed and through it the steam with the air that had been drawn in escaped. Afterward an opening about 4 inches in diameter was made in the top for the purpose of admitting air. The steam pressure in the blast-pipe was regulated by means of a hand-cock and measured by a quicksilver gage, while the vacuum that was induced in the chamber was also measured by a similar gage and a water column.

The stacks, of which there were five, had clear diameters of 1.6 inches, 3.2 inches, 3.9 inches, 4.7 inches and 5.8 inches, while the blast-pipe had diameters of .39 inches and .56 inches.

In the air opening for the purpose of changing its sectional area there were placed rings having clear openings of .39 inch, .78 inch, 1.56 inches, 2.26 inches and 3.15 inches inside diameter.

From these investigations, which embraced over 2,000 measured observations with this apparatus, and from his theoretical opinions, which were the first upon this subject that were examined in so thorough a manner, Zeuner came to the following conclusions:

1. The distance x , as given in Fig. 2, which is the distance of the top of the nozzle from the bottom of the stack, can be varied between tolerably wide limits, without particularly disturbing the evenness of the ratio of the vacuum existing in the chamber during the outflow of steam.

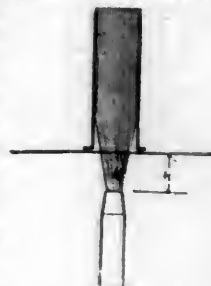


FIG. 2.

Nevertheless, he adopted as the result of his investigations 1.57 inches as being the distance equal to x , at which the stream of steam could enter the different stacks with the least hindrance.

2. In general, the opening of the blast-pipe must be raised and brought nearer to the mouth of the stack, as the latter is made smaller, provided the vacuum is to be kept the same. It may be possible to take the distance of the opening of the blast-pipe below the opening into the stack as equal to from one to two times the diameter of the stack that is being used.

3. In general it happens, in consequence of the friction of the steam and air in the stack, that there is a marked diminution of the suction action of the stream of steam, if the length of the pipe is more than 30 times the diameter.

4. It was also observed that the position of the blast-pipe relatively to the opening into the stack, the capacity, and, in a general way, the very shape of the smoke-box of a locomotive, and, finally, the height of the stack, have all a very important influence upon the action of the exhaust. At least it may be asserted that locomotives built to-day in accordance with these directions can hardly be improved.

5. The vacuum—that is, the difference existing between the pressure in the chamber and that of the atmosphere—in, creases in a direct ratio with the steam pressure. It does not depend upon the absolute size of the steam opening, the air opening and the stack, but upon the ratio existing between the first and the last, and the quotient:

$$\frac{\text{Area of steam opening}}{\text{Sectional area of stack.}}$$

6. For a given size of blast pipe and air opening, there is always some diameter of stack, wherein the sucking action of the steam current is the greatest, and with all other diameters this action is weaker. This point of maximum efficiency leaves one in a position to define the theory of the action very sharply.

7. With the same nozzle opening and stack, the amount of air drawn in varies directly with the square foot of the steam pressure.

8. The ratio existing between the vacuum in the smokebox and the pressure in the exhaust-pipe is variable, and, with the ordinary blast-pipe arrangements, depends essentially upon the cross-section of the blast-pipe opening and a known co-efficient, u , indicating the resistance of the products of combustion in the tubes. If, therefore, we adopt the common acceptance of the results of Clark's experiments, which have been used up to the present time, this ratio becomes one-fourteenth for locomotives, and that only an approximation and applicable, also, only to the locomotives upon which Clark conducted his investigations. On the whole, however, it appears that, when everything has been taken into consideration, this ratio can be subjected to no very great fall, provided the heating and running of the locomotive is normal.

* Translation of a paper read before the German Society of Mechanical Engineers.

It must be remarked just here, however, that the conclusions announced in Nos. 1, 3, 4 and 6 are not in accord with the results of the experiments carried out in the Leinhausen shops in the years from 1892 to 1894. In opposition to Zeuner, it must be said that the position of the exhaust nozzle relatively to the bottom of the stack, as well as the length of the stack, certainly does have an influence upon the working of the draft. Further, this is evidently not limited to a stack having a length equal to 30 times the diameter, but to one with a length of six diameters. Finally, that diameter of stack which showed the highest vacuum in the apparatus cannot be said to be universally the most efficient, since upon a locomotive it might act very unfavorably. We can see from the data developed by the Hanover experiments that the vacuum rises, the other conditions remaining the same as the stack is made smaller; that is, within certain defined limits and beyond these limits it falls rapidly away. This stack, which in the apparatus gave the best draft, is too small for a locomotive, the ratio between whose grate and tube areas is based upon the dimensions of the experimental apparatus, and, consequently, would not give a proper draft to the fire nor an economical coal consumption, and so cannot be claimed to be the most economical. This brings up still another influence that will be referred to later.

That Zeuner reached the other results which he has promulgated depended upon his choice of the dimensions of his apparatus. Not only was the stack altogether too long, but it was far too large in comparison with the diameter of the blast nozzle that was used. The latter had, as we have already said, a diameter of only from .39 inch to .56 inch, while the former was 1.6 inches, 3.2 inches, 3.9 inches, 4.7 inches, and 5.8 inches. Hence, the diameters of these stacks were 4, 8, 10, 12, and 15 times as large as the .39 inch blast nozzle.

Now, in actual locomotive practice, as well as in the recommendations of Zeuner, we have nozzles varying in diameter from 3.5 inches to 5 inches. Suppose we take one with a diameter of 4 inches, we must, in accordance with the data given by this apparatus, have five stacks with diameters of 16 inches, 32 inches, 40 inches, 48 inches, and 60 inches, sizes which naturally are wholly out of the question for practical work. Then, too, the smallest stack of the Zeuner apparatus gave values that varied from those obtained from the other four large ones, yet Zeuner disregarded it in his investigations, although it approached more nearly than any of the others to locomotive practice; and, in addition, the vacuum was very low, giving a water column of only 1½ in. with an excess of blast-pipe pressure of ¼ atmosphere, while in actual locomotive service it is at least double this, with a blast-pipe pressure that is considerably lower.

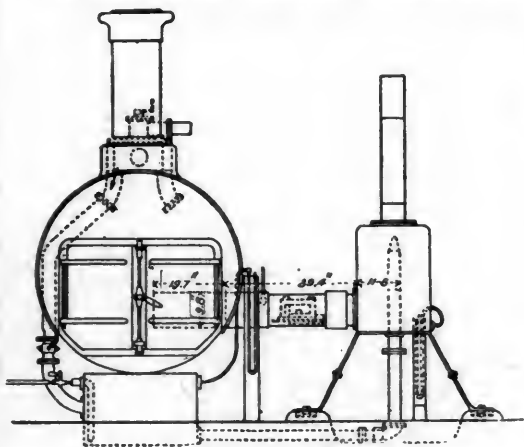


FIG. 3.—THE NOZO AND GEOFFROY APPARATUS.

It is also highly probable that in the further stack experiments air was drawn in from above, as was shown to be the case in the Hanover experiments. From this point of view, also, Zeuner found a very slight difference in the vacuum, whether he conducted his experiments in an open or perfectly tight chamber, and from the same standpoint he found no marked influence due to the length of the stack, although he gradually shortened it from an original length of 4 feet 11 inches to 14½ inches. What an important influence this variation in length does have upon the action of the exhaust is evidenced by the Hanover experiments. Although it should happen that not one of the values derived from these experiments should have a practical working value, we still have the service which the genius of Zeuner rendered in developing the theory of the blast-pipe, and for which the painstaking investigations which he carried out were necessary.

Nozo and Geoffroy.—At almost the same time with Zeuner—that is, in the fall of 1890—the French engineers, Nozo and Geoffroy, carried out some similar experiments, independently of Zeuner, but also with cylindrical stacks only, since up to that time no other shape was known. The apparatus used by them is illustrated in Fig. 3. It was similar to the Zeuner apparatus, yet with this essential difference, that it was not cold air but the products of combustion of a locomotive which were drawn in, and that the boiler of the same supplied the steam for the experiments. The steam was led from the throttle into a special reservoir of 11.3 cubic feet capacity, and in this, while each test was being carried out, a constant pressure was maintained, which could be accomplished by means of the throttle-valve and one on the reservoir opening into a wastepipe. The blast-pipe chamber also had a capacity of 11.3 cubic feet. In the pipe used for conducting the products of combustion into the chamber, an anemometer was placed which could be read through a glass-covered peephole. In order that the experiments might be carried on with openings for the admission of air of different sizes, false plates with holes of the same size, but varying in

the number of the same, were placed in the blast chamber in front of the air-pipe. During these experiments the locomotive boiler was fitted with a stack 21 feet 3¾ inch high, whose natural draft sufficed for the generation of the steam.

The experiments were made with four blast-pipes of .39 inch, .55 inch, .79 inch, and 1.1 inches diameter, and 10 stacks varying in diameter from 1½ inches to .79 inch in diameter. The height of the latter was equal to eight times its diameter. The perforated plates had a free sectional area through holes of .35 inch diameter that varied in number from 20 to 320. The steam pressure in the receiver varied from 1 to 11½ pounds per square inch.

Upon using a blast nozzle having a diameter of 1.6 inches, a stack 5.5 inches in diameter, and a steam pressure of 2 pounds per square inch, a vacuum equivalent to a water column of 1.7 inches would be obtained in the smokebox of the apparatus, while the temperature of the air that had been drawn in would be about 313 degrees Fahr. If the steam pressure was increased threefold to 6 pounds per square inch, a vacuum of 5.55 inches would result, and the temperature would rise to 331 degrees Fahr., which was about one-half the true temperature. Nozo and Geoffroy arrived at the following conclusions:

1. Each length of stack that gives the maximum results is independent of both the area of the blast nozzle and the passage for gases, but not of the steam pressure, and is but slightly independent of the diameter of the stack. It must be from six to eight times that diameter. A greater length has no influence.

2. A funnel-shaped opening to the bottom of the stack seems to have no marked influence upon the draft.

3. A stack of suitable length can project down into the smokebox to the top row of tubes without injury to the draft, if the blast nozzle is dropped at the same time; but the draft is very seriously impaired if the lower end of the stack is plunged down into the stream of gases.

4. With a proper length of stack—that is, one varying from six to eight times the diameter—the distance of the nozzle from the stack has no marked influence so long as this distance does not exceed one and one-half times the diameter of the stack; when this is exceeded the draft is materially injured. The projecting of the nozzle into the stack seems to have no detrimental influence worth mentioning, so long as the adjustment of the nozzle is such that it is in true alignment.

5. With a given sectional area of the tubes and nozzle, and a given velocity of flow of the steam, there will be one sectional area of stack that produces the greatest draft, the length being held at from six to eight times the diameter. In the neighborhood of this area the diameter of the stack can be subjected to considerable variation, without having any very great influence upon the amount of air that will be drawn in.

6. If with the same tube area or the same resistance the nozzle be changed from double to single, the result will be according to five, that for a given stack and velocity of steam flow the draft will be increased.

7. An ordinary stack of a given section and a single nozzle can be replaced by a multiple stack and a multiple nozzle—that is to say, a single large nozzle can be replaced by a bundle of small tubes.

To these conclusions it may be remarked that the length of stack as they found it is too great, and is doubtless to be attributed to the small dimensions of the apparatus that was used. The ratio which corresponds to the effective action, as shown by the Hanover experiments, is that, for the maximum draft, the length should be from four to five times the diameter. Furthermore, the funnel-shaped opening does have a very important influence upon the draft, since it offers free access for the gases to the current of steam.

Likewise conclusions 3 and 4 do not coincide with locomotive experience, and the same may be said of the concluding portion of No. 5. As has already been noted, Zeuner says that a stack always maintains the best draft at a given ratio. Conclusion 6 is likewise at fault, for, for each diameter of nozzle there is also only one cylindrical stack that will give the maximum draft, provided the length remains unchanged, whose diameter increases the larger the nozzle that is used with the same steam pressure.

Conclusion 7 is of no practical value for locomotive work; Nozo and Geoffroy also conducted their experiments upon a running locomotive while it was hauling a train. In this work they used seven different stacks having diameters of 9 inches, 11 inches, 12.5 inches, 14 inches, 15.4 inches, 17.7 inches and 17.8 inches, whose lengths were 6 feet 2.8 inches. The nozzle had a diameter of 4.3 inches, with its opening 3.9 inches below the bottom of the stack, so that the effective height of the stack was 6 feet 6.7 inches.

The results obtained from these experiments were as follows:

The three stacks, with diameters of 9 inches, 11 inches and 17.8 inches, were useless, while with the other four the trip could be readily made on schedule time. The stacks with diameters of 12.5 inches, 14 inches and 15.4 inches diameter, gave a plentiful supply of steam. A graphical result was drawn for each stack, and these showed that the diameter of 14 inches was the best for the locomotive under consideration.

Regarding these experiments, it may be said that the action of the stack appears to be judged entirely by the amount of draft obtained; but this construction is not the only one that should have an influence, for, in Germany at least, it is required of the stack that the fire shall not only work properly and burn quietly, but that the amount of coal that is carried from the firebox to the smokebox shall be as small as possible, thus cutting down the amount of sparks and cinders. It seems odd, too, to note in this report that with a stack of 17.7 inches diameter the trip was made on schedule time, while with a stack of 17.8 inches in diameter, or only .1 inch larger, the action was unsatisfactory. Here, at all events, there must have been some other circumstances at work which could not have been known to the observers, so that the experiments of Nozo and Geoffroy are of little

value for the construction and operation of locomotives of the present day.

Prusmann. A later experimenter in this matter, Prusmann, the inventor of the conical smokestack that has been named after him, must be mentioned. He began his experiments about the end of the year 1890, which was at about the same time as those conducted by Nozo and Geoffroy, but he went into the work so extensively, that they were not completed until the beginning of 1893. His paper was published in the *Organ für die Fortschritte des Eisenbahnwesens* in 1895, and in the same year it also appeared in book form, where he gathered together his extensive results that had been reached with so much labor.

In Figs. 4, 5 and 8 the experimental apparatus that was used by Prusmann is shown. Fig. 4 shows the first arrangement that was used. It consists of a cylindrical box only 3.23 inches in diameter, through whose cover the cylindrical stacks having the same outside but varying inside diameters could be slipped and then held in any desired position by a set screw. The blast-pipe entered through the bottom, and was connected with the boiler by means of a pipe in which a cut-off cock was placed. The opening of this cock could be

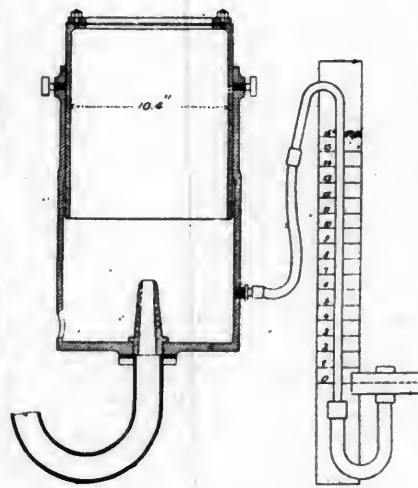
Fig. 4.



Fig. 5.



Fig. 8.



made anything that was desired by means of a handle fastened to its square stem and moving over a graduated arc, thus permitting of an exact regulation of the blast-pipe pressure. Directly over the bottom of the box, as shown at the left in Fig. 4, there was an opening 1½ inches in diameter, through which the air was drawn in by the suction created in the interior. The vacuum was measured by a water column in the form of a siphon shaped glass tube, whose connection with the box was packed with a rubber washer, the exact blast-pipe pressure not being obtained, but merely that existing in the boiler, while the experiments were in progress, which was read on a metallic pressure gage. In his experiments Prusmann chose only such openings of the cock on the apparatus as would produce a vacuum equal to that prevailing at that time in the current practice on the locomotives of the Hanoverian State Railway—namely, from 6 to 7 inches, which was obtained by placing a stack on the experimental apparatus corresponding to that in use upon these locomotives. The nozzle of the blast-pipe had a clear diameter of 0.32 inch, and the seven cylindrical experimental stacks had diameters of about 1.25 inches, 1.33 inches, 1.5 inches, 1.58 inches, 2.125 inches, 1.7 inches and 1.77 inches.

Prusmann formulated the following conclusions as the result of his experiments:

1. The blast-pipe pressure within the limit of current practice has no influence in determining the proper shape of the stack.

2. The increase of the distance from the bottom of the stack to the top of the blast nozzle is not exactly an equivalent, but as it is increased, of course within certain limits, it is accompanied by a corresponding increase in the height of the vacuum.

3. Of the seven experimental stacks used, the one of the mean diameter of 1.58 inches showed the best results.

4. With a stack of the most efficient diameter, its height should be so adjusted that it stands at least four times the diameter of the blast-pipe above it, in order that this latter may be at a proper distance from the lower end of the stack.

5. For every height above the blast nozzle there is one cross-section of stack that will give the most efficient working.

In order to investigate these latter results which he had obtained, Prusmann changed his experimental apparatus so that he replaced the solid cover by a movable open shell, like that shown in Fig. 5, that could be fastened in position, and on the upper end of which plates having circular openings of different sizes could be bolted. The diameter of the openings in these plates varied by one-eighth inch from 1 inch to 2¼ inches. By changing the shell the 11 plates were set at a greater and greater distance from the blast-pipe, varying from 0 to 7.6 inches, and in this way the vacuum was measured for 39 different positions. Prusmann thus obtained 11 series of results with 39 figures in each, which he put together in the form of a table, and in such a way that for each of the 39 positions of the blast-pipe the 11 different vacuums that were obtained formed a horizontal series. In each of the vertical, as well as the horizontal, series there was one of the highest efficiency.

He drew therefrom the following conclusions:

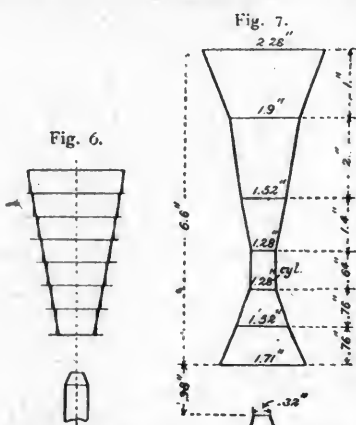
6. For each diameter of opening in the plates there is one distance from the blast-pipe that gives the highest vacuum.

7. The proper form of stack is not a cylinder, but a pipe whose diameter varies with the distance from the blast-pipe.

Now when Prusmann had laid out the blast-pipe distances already mentioned upon a vertical axis, and had then drawn parallel lines through these points, he then laid out upon each side of the vertical, the radius of that plate opening which, for the corresponding distance from the blast-pipe, gave the highest vacuum, and thus obtained a series of circular sections, as indicated in Fig. 6, that outlined the general average form of a cone, and from which the conical form of stack was deduced.

Prusmann made a stack of this shape out of tin, placed it upon the apparatus, and ascertained, by very careful adjustments, that distance of the lower end of the same from the blast-pipe where the highest vacuum was obtained. He then experimented with several tin stacks of similar shape and finally developed that shown in Fig. 7 as being the form that showed the highest efficiency.

It is worthy of note that a cylindrical section was located in the narrowest portion for the sake of avoiding the sharp angle that would otherwise exist between the top and bot-



tom parts, and thus avoid a too rapid widening above and below.

Prusmann then made a stack for a locomotive of exactly this shape, with dimensions proportioned in the ratio of the blast-pipe dimensions of the locomotive to those of the experimental apparatus, which was $\frac{2.79 \text{ in.}}{0.32 \text{ in.}} = 8.594$. The most

contracted portion of this stack had a diameter of 11 inches and stood at a height of 27 inches above the top of the nozzle. The locomotive upon which it was placed, and which had formerly made sufficient steam to do its work with a cylindrical stack having a diameter of 15 inches, was now found to act in such a way that the exhaust nozzle could be opened .28 inch, and an average saving of 23.81 per cent. in the consumption of coal effected, which in some cases arose to as much as 42.2 per cent. On a second locomotive, which had a blast nozzle of about 42.2 per cent. greater diameter, or of 3½ inches diameter, and a conical stack of correspondingly larger dimensions, or $\frac{3.875}{0.32} = 10.547$ times larger than those

given in Fig. 7, the experiment was a complete failure. "The production of steam was often insufficient, and the coal consumption for the same loads was even increased." From this Prusmann concluded that his method of treatment was a wrong one, in increasing the dimensions of his experimental apparatus in a direct ratio, for it appeared that in the case of the 42.2 per cent. increase in the size of the blast-pipe he had taken it for granted that the grate area had been increased in the same proportion. In order to obtain information upon this point Prusmann built a third and larger apparatus. Fig. 8 illustrates this on a scale of one-tenth its actual size. The larger scale, which was attached to the water-gage, enables more accurate readings to be taken than were possible with the siphon gage. This third apparatus varies from the two others and also from the apparatus of Zeuner and Nozo in that it had three openings arranged concentrically with the blast-pipe, through which the air that was drawn in entered, and which favored the production of the vacuum. The size of these three openings was ascertained from a locomotive whose wheels and pistons were blocked. The valve was raised and so arranged that with the throttle wide open only so much steam could escape through the blast-pipe by way of the contracted openings ~~the~~ the valve passages, that with the ash-pan damper open, as it usually was while running, a vacuum of 6.8 inches of water was obtained in the smokebox. Then the ashpan damper was quickly closed tight, the tube openings into the smokebox closed as tight as possible with sheet iron, and an air damper in the smokebox door opened until a vacuum of .68 inches was again obtained in the smokebox. This gave, for coal and coke burning, a free opening equal to the total grate area divided by 21. This ratio was incorporated in the apparatus, and a series of experiments made which also included the use of a nozzle of $\frac{3}{4}$ inch and one of 1 inch in diameter, with which the height of the stack opening above the same varied from $4\frac{1}{4}$ inches to 25 inches. The results obtained were again tested in part with the small experimental stacks, and led to the following conclusions:

8. Making the conicity of the blast-pipe more blunt has a tendency to lower the stack, but, on the other hand, the conicity of the blast-pipe is without any influence upon the distance of the smallest portion of the stack above the nozzle, or upon the diameter of that portion.

9. Under the same circumstances the taper of the shells of stacks remain nearly the same for all locomotives in similar service, provided only that the ratio of the cross-section of the blast-pipe to the grate area remains the same.

10. A stack made for a given blast-pipe must, if all the other ratios remain the same, be enlarged over all by about the difference in the blast-pipe diameters, if we wish to use a larger blast-pipe with this same taper.

11. On non-condensing locomotives, whereon it is desired to increase the diameter of the blast-pipe, if the blast-pipe pressure remains the same, the distance of the smallest portion of the stack from the top of the nozzle will be unchanged.

12. The upper portion of the smokestack lying above the smallest portion of the same does not consist of a single truncated cone, but of three truncated cones of different inclinations, these inclinations becoming greater toward the top.

Finally, Prusmann gave a number of formulæ for calculating the dimensions of stacks and blast-pipes. The one for the location of the blast nozzle taken as t for all locomotives is:

$$t = 2.3673 + 0.857,047,767 \delta - 0.136,138,202 \delta^2 + 0.525,258,551 \delta^3,$$

wherein δ is the diameter of the blast nozzle in inches.

It may, however, be remarked that, though these experiments were carried out so thoroughly and with so much trouble (for in all Prusmann used 18 different stacks on his apparatus, two of which were similar to those used upon locomotives, and 26 different plate openings) they are not entirely free from objections. Next the dimensions of the experimental apparatus were altogether too small, while the method of measuring the steam pressure was defective. In the first place, the boiler pressure should not have been measured, since it is always liable to a continual shrinkage; secondly, the boiler used had to supply steam for the shop engine, the works, and then these measurements should not have been taken with a metallic gage, since it was evidently far from being sensitive enough for a current of steam flowing through an opening of 0.3 inch. A quicksilver gage should have been used in this place, by means of which an accurate measurement could have been made of the pressure existing between the blast nozzle and the controlling cock. By moving the long handle attached to the cock, it would have been easy to have held this pressure at one point. It is to the imperfection of these measurements that we must ascribe the fact that, from the various tables of figures given by Prusmann, no accurate diagram of exactly what took place can be reproduced: for if we make a graphic delineation of the values given for a series of experiments, we get in most cases not a regular curve, but a broken line, between whose several parts there are wide variations of direction, and this is especially the case if we refer to Tables I, III, V, XII, and XVII. of Prusmann's work. In the last-named table there are, in several instances, two different values for the vacuum produced by the same position of nozzle, which is evidently impossible if the steam pressure remains the same; but before all others in inaccuracy is the statement that that plate opening which, with a given position of the nozzle, gave the best vacuum is the most efficient. This is seen, as a glance at the table teaches, in that the shortest distance is an accompaniment of the smallest opening, while the greatest distance between nozzle and plate is the one belonging to the next to the smallest opening. From which the stack indicated therefrom would evidently be too small. With the stack thus obtained Prusmann experimented still further, and deduced therefrom each location of blast nozzle from the smallest section of stack under consideration, at which the highest vacuum could be produced. This distance he now took as that at which the highest efficiency could be obtained, and transferred it into terms of the ratio of the diameters of exhaust nozzles upon locomotives; but such a performance is not at all permissible, as the Hanover experiments clearly show, for these nozzle distances having the strongest action come out many times as great on many locomotives. If we were to make an application of the Prusmann formulæ given above to exhaust nozzles of 4 inches or 5 inches in diameter, the distance of these nozzles from the smallest section of the stack would, according to Prusmann, be 37.8 inches for the first and 70 inches for the second, values that are unheard of in practice. That the Prusmann stack is above all things too small has long been known. Grove speaks of this in his well-known "Theory of the Blast-Pipe" (1874), and frankly discusses the reason therefor in "The Impossibility of Establishing the Shape of the Stack by Means of the Passage of a Current of Steam through Openings in Thin Plates," but, as we have stated above, this is not the principal reason for objecting to the results given.

There are, however, some results which Prusmann obtained from his experiments, inaccurate as they were in part and inapplicable as they are to the practice of the present day, which are full of significance for all time, and among them are those that led to the construction and development of the conical stack, which by varying its height above the nozzle within certain limits produces the best vacuum.

Zeuner: A very interesting continuation of the experiments of Prusmann was commenced a year later by Zeuner, and published in 1871 under the title of "On the Action of the Blast Apparatus of Locomotives with Conical Flaring Stacks."

Unfortunately Zeuner had, as he says in writing of this work, no knowledge of the results which the Prussmann experiments had yielded, so that he turned to his earlier experiments with cylindrical stacks that were previously briefly outlined but in other respects the information elicited was that resulting from a purely mathematical calculation. In consequence thereof his theory included, not the conical stack, but the location of the blast nozzle and its influence upon the action of the draft; the length of the stack is also disregarded. He laid down the following principles:

1. For a given diameter of blast-pipe and sectional area through the tubes, there is one most efficient sectional area of stack, measured at the smallest point, with which the maximum draft can be obtained.

2. The vacuum in the smokebox and the inrush of the mixture of air and gases increases as the flare on the upper end of the stack is increased, but a moderate amount of this flare soon gives an action that is perfectly satisfactory.

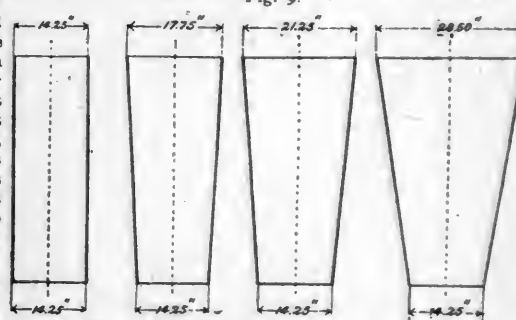
The conical stack will admit, for the same draft action, of a large exhaust nozzle opening. For the same train speed, therefore, it gives more power to the locomotive than the cylindrical stack, on account of the decrease of back pressure upon the pistons, which thus increases its mean effective working and lessens the fuel consumption in consequence.

In its general significance, conclusion No. 1 is not applicable to locomotives; the same thing may be said here that was remarked above relative to cylindrical stacks.

The results of the Hanover experiments are also at variance with the statement of No. 2. Zenner reconciled his theories off-hand by taking a blast nozzle 3.94 inches in diameter, a cylindrical stack of 14.25 inches diameter with three conical stacks, as shown in Fig. 9, all of whose smallest diameters were also 14.25 inches, while the upper diameters were 17.75 inches, 21.25 inches, and 28.5 inches. He then calculated that the stack with the widest flare—that is, the one with the upper diameter of 28.5 inches—would draw in the most air with a given amount of steam, the blast nozzle remaining the same, and that it is also the most efficient.

The Hanover experiments, on the other hand, showed that if the upper diameter of all stacks is kept the same, while the lower diameter is varied, the strongest draft and consequently the greatest inflow of air will be obtained with that having the smallest diameter. If we start, as Zeuner did, with equal lower diameters, we find from tables X and XII, that give a graphical representation of the Hanover experiments, the very reverse to be the case to what Zeuner theoretically maintained.

The third of the Zeuner conclusions that we mentioned above is also not in accord with more recent experiments, for, as I shall show later on, the conical stacks are not



superior to the straight stacks in inducing draft. Both forms, if properly proportioned, therefore, admit of the use of the same diameter of blast-pipe for the production of the same vacuum.

Grove: We come now to the mention of Grove as the last to pursue this line of investigation. In a handbook compiled by Heusinger von Waldegg on special railroad technical work, he has handled the difficult question of the blast-pipe in a very lucid manner, has advanced some excellent theories, especially with reference to the position of the blast-nozzle with reference both to cylindrical and conical stacks. His formulae are especially valuable for locomotives with small grate areas, but for those having larger areas the calculated diminutions are too small.

In his theory Grove followed in the footsteps of Zeuner relative to the action of the draft, and also advocated the superiority of the conical stack. In paragraph X, that has been already referred to, this comparison is pointed out off-hand, and that in connection with the sectional area of the tubes and not of the grate area, whereby the error is called forth. The tradition regarding the superiority of the conical stack is referable to Prusmann. He compared a cylindrical stack, which was evidently too large with reference to the blast nozzle, as shown in Fig. 11, with a conical one whose dimensions were too small. The former had a diameter of 15 inches, and the latter was 11 inches at the waist. The result was that, with the first, the blast nozzle was flush with the bottom of the stack, while, with the conical stack, it was placed 27 inches below that point. Had Prusmann contracted the cylindrical stack correspondingly and then lowered the blast-pipe, he would doubtless have obtained the same improvement in the action of the draft on his locomotive as he did obtain by the application of his small conical stack.

This demonstration of the equality of the two forms of stacks is one of the important achievements of the Hanover experiments.

(To be Continued.)

The largest man in the world is on exhibition in Paris. He is 6 feet $\frac{1}{2}$ inch tall, and weighs 520 pounds. His upper thigh measures 4 feet 1 inch around; his calves measure 2 feet 11 inches, and his upper arm is 1 foot 11 inches around. He measures 7 feet $\frac{1}{2}$ inches around the waist. He is a French-Swiss.

Prospects of Electric Motive Power on the Illinois Central.

In an interview concerning the recent reports of the Illinois Central Railroad and its intention of adopting electric motive power for suburban traffic, the following statements were made by Mr. J. F. Wallace, Chief Engineer of the road.

"In 1891-92 I made an extensive examination into the advisability of adopting electric power for the fast world's fair trains, and with a view to adopting the electric system, if any should be established, for the movement of suburban trains after the Exposition. The result of this investigation was that I reported to my superior officers against the adoption of electricity as motive power. The question has not been officially considered by the officers of this company since 1892, although the progress of electrical invention has been carefully watched and I have personally on my own responsibility, as a matter of engineering interest, been following the advances made towards electric traction for heavy suburban railroad service. I have frequently said I had no doubt that some time in the near future the Illinois Central would take up and consider this question and that conditions were gradually shaping themselves which would make this application possible; not, however, from any pre-conceived plans for the adoption of electric motive power, but from the fact that the requirements of the service made the conditions more favorable for taking this step.

"I do not think the overhead trolley system will give satisfaction, neither do I consider the third rail system feasible on account of the large number of trackmen working on the terminal and the numerous trespassers crossing and recrossing the tracks. The application of electricity to a service like that of the Illinois Central will necessarily be gradual and slow, and any system that may be adopted should be such as would permit of the common use of the tracks by steam power as well. In other words, the question of the application of electricity on this road is still in the air and while current events indicate that the application will be made in the near future, it may be two, three or five years before the question is even seriously considered.

"Inside of certain limits electricity seems to be the preferable motive power for moving small transportation units at frequent intervals and for short distances; while on the other hand steam is the most economical and preferable for handling large units of transportation at infrequent intervals and over long distances. The line of demarcation between these extremes, is, of course, rapidly changing, and the field for the adoption of electric power is gradually increasing as the appliances therefor are more thoroughly perfected and the problems of economical constructions, maintenance and operation are solved."

An Extraordinary Litigant.

Referring to legal proceedings against the Magnolia Metal Co. in a New York court, the *Commercial Advertiser* recently said:

"The case of *The People vs. Shanks* will probably make a little history—legal history, but still history. It is pretty difficult to conceive of a man who, without any possible interest himself, will sue a large corporation, go on his own bond in filing an attachment, knowing all the while that he had not a cent in the world, and could not satisfy judgments of many years' standing against him. Yet this is what was developed in the case of *The People vs. Shanks*. Shanks brought an action last spring against the Magnolia Metal Company on an assigned claim by discharged employees, for \$7,000. As the Magnolia Metal Company was a foreign corporation, some one had to qualify as surety in bringing an attachment suit. As a matter of fact, Shanks acted both as plaintiff and bondsman. More extraordinary still, he did so on the advice of counsel, who knew his financial condition, and, to add to the incongruity of the situation, his counsel stated that Shanks had no pecuniary interest in the assigned claim in question.

Col. Alexander S. Bacon, of 34 Wall street, did the probing; Mr. Linus A. Gould and S. Victor Constant, of Constant & Coghill, assumed the responsibilities for the action of his client, Shanks, and Police Judge Kudlich heard the case and couldn't see any particular merit in the plea that the alleged perjury was advised by counsel. Colonel Bacon, the attorney for the Magnolia Metal Company, has for years been attending litigation growing out of suits brought by dummies in the interest of large corporations inimical to the Magnolia Metal Company. The petty annoyances have grown to be intolerable, and the company is invoking the law and is bringing these irresponsible offenders to justice. It is an open question whether a trust is not forming in the anti-friction metal business, and the fact that the Magnolia people have the standard metal which, for about the same price, gives three times the same service, has undoubtedly excited the cupidity of competitors who wish to take over the company's assets and good-will without paying for them.

Mr. C. B. Miller, president of the Magnolia Metal Company, stated in an interview that he had traced discharged employees directly to the offices of the National Lead Company, the Hoyt Metal Company and others. He also stated that his company had brought suit against the Sterlingworth Railway Supply Company for \$120,000 damages for breach of contract, under circumstances which bear out the theory of an attempted combination in bearing metal. One of the leading stockholders of the Sterlingworth Railway Supply Company is said to be a prominent official in the Standard Oil Pipe Line.

In spite of considerable persecution, the Magnolia Metal Company has thrived to such an extent that its very metal is now in use in most of the navies and railroads of the world as well as in all classes of mechanical industry. However,

the adoption of such methods as are disclosed in the Shanks case and the countenance of them by the members of the bar is a serious menace to all honestly conducted enterprises.

Evaporative Trials of Belleville Boilers.

The London *Times* of Oct. 28, contained a notice of the launch of the *Kherson*, built by Messrs. R. and W. Hawthorn, Leslie & Company, for the Russian Volunteer fleet. This vessel is to be fitted with propelling engines which are to indicate 12,500 horse power on trial, the steam to be supplied by 24 water-tube boilers of the Belleville type placed in three separate water-tight compartments. The boilers are being constructed by Messrs. Maudslays, Sons & Field, at their works at East Greenwich.

The following account of the trial of these boilers was given in a late number of the *Times*:

For the purpose of the evaporative trials the boilers have been built up where they have been made, the furnace sides and ends being constructed of fire-brick in the same way as if they were *in situ* on shipboard. Although partially under cover, they were practically exposed to the condition and temperature of the external air, which were not very favorable. In the two boilers under trial, each of which consists of eight tube sections or elements, a section containing 20 wrought-iron tubes $4\frac{1}{2}$ inches outside diameter and about 8 feet 6 inches long; the total heating surface is 2,946 square feet and the grate area 93 square feet. As only two boilers were to be tested, a temporary uptake and short funnel were provided, the deficiency in natural draft due to this compulsory arrangement being made up by the application of a steam blast. To insure that all should be in readiness for the official trials, which were to take place on Friday, a preliminary trial of them of six hours' duration was made on the previous Tuesday—the weather being very cold—with results as tabulated below:

Hours of Day.	Coal Burned.	Water Evaporated.	Evaporation per lb. of Coal.	Boiler pressure, lbs. per sq. in.	Blast pressure, lbs. per sq. in.	Coal Burned per sq. ft. of grate.
	Lbs.	Lbs.	Lbs.			Lbs.
11-12...	1,848	16,500	8.92	200	20	19.8
12-1...	1,747	16,500	9.44	200	23	18.7
1-2...	1,812	16,125	10.66	195	23	16.2
2-3...	1,747	16,500	9.44	195	23	18.7
3-4...	1,792	16,300	9.30	198	23	19.2
4-5...	1,568	17,000	10.81	198	23	16.8

These figures, when run out to their conclusions, give a mean for the whole six hours of the trial of 9.76 pounds of water evaporated per pound of coal consumed, and 18.23 pounds of coal burned on each square foot of fire grate, the mean pressure of the steam being 197.6 pounds per square inch. During the whole of the six hours the mean temperature of the feed water was 64 degrees Fahr.

With these results, the official trials of Nov. 1 (which were to be of 12 consecutive hours' duration) were entered on with confidence. The weather, however, at the start was not propitious, the air being laden with a heavy damp fog. At 5:40 a. m. the fires were lighted, the temperature of the atmosphere being 50 degrees Fahr.; at 6:20 a. m. the steam gauges registered 200 pounds pressure in the boilers; and at 6:30 a. m. the measuring of coal and water was commenced, and continued for purposes of adjustment, when it was found that 18 hundred weight of coal was being burned in the hour and the water evaporated 8.8 pounds per pound of coal. At 8 a. m. the official trial was commenced, and continued for the time agreed upon, terminating at 8 p. m. with the following result: The average evaporation for the first three hours amounted to 9.2 pounds of water per pound of coal burned; for the first six hours, 9 pounds of water; and for the entire 12 hours, 8.81 pounds of water per pound of coal, the steam pressure being 200 pounds to the square inch throughout; and the temperature of the feed water 64 degrees Fahr. Welsh steam coal of average quality was used during the trial, and the fires were cleaned at the end of the sixth and tenth hours. At the conclusion of the 12 hours trial, an accumulation test was made to ascertain if the safety valves were capable of dealing with any quantity of steam likely to be produced. The valves were accordingly set to lift at 245 pounds' pressure per square inch, and firing was resumed and coal burned at the rate of from 35 pounds to 40 pounds per square foot of grate per hour. The maximum pressure shown by the gauges during the hour in which this test was continued was 247 pounds. During the whole of the 12 hours of trial all the coal weighed was fired, and no allowance made for cleaning the fires or for what had fallen through the grates.

As the Belleville type of boiler is now attracting considerable attention, its more extended adoption in naval and commercial vessels being imminent, much interest was manifested in these tests, which were attended by several engineering experts, in addition to the representatives of the builders.

The "Star" power hack saw, made by the Millers Falls Company, of 93 Reade street, New York City, is a time and labor saving machine, that is worth a good deal more than it costs. The machine will cut metal of all sizes up to $4\frac{1}{2}$ inches in diameter. It requires no attention after the work is put in the vise, and stops when the piece is cut off. The quality of the blades used in these machines has been steadily improved, as shown by the fact that one blade recently cut off an inch square bar of wrought iron 246 times. This could not be done in a hand frame, but in the "Star" power hack saw, where the pressure and stroke are regulated and uniform, one blade will cut steadily for a number of days.

The Root Boilers All Right.

In November last a suit was begun by the Philadelphia Edison Electric Light Company, of Philadelphia, against the Abendroth & Root Manufacturing Company, of New York City, to recover \$34,000.00. A countersuit was put in by the Abendroth & Root Manufacturing Company against the Philadelphia Edison Electric Light Company, for \$6,830.90. This suit was tried in the United States Court in Brooklyn, before Judge Wheeler and a jury, and a verdict has now been rendered in favor of the Abendroth & Root Manufacturing Company for the amount of the countersuit.

The Abendroth & Root Manufacturing Company are the manufacturers of the well-known Root Water Tube Boiler, and between the years 1889 and 1891 they furnished the Philadelphia Edison Electric Light Company with about 3,500 horse power of boilers, these boilers being supplied on four different contracts, each of which followed the other at short intervals. Soon after these boilers were erected and in operation in the Philadelphia-Edison plant, a series of troubles followed, which finally culminated in a fatal accident. This brought the matter into the Coroner's Court in Philadelphia, where, after a careful investigation by a jury of experts, a verdict was rendered acquitting the Abendroth & Root Manufacturing Company, and holding the Philadelphia Edison Electric Light Company responsible.

The troubles above mentioned were due, as claimed by the Philadelphia Edison Electric Light Company, to bad workmanship, bad material and faulty design, and also due to the contractors failing to comply with all the articles agreed upon in their contract, and on these grounds they brought the suit just closed, in which they sought to recover \$34,000, which they claimed they had spent in remedying the so-called defects. The Abendroth & Root Manufacturing Company claimed that the plaintiffs had not paid them all that was due on their orders for boilers, and also for additional material furnished to them, and on these grounds they brought the countersuit mentioned above.

The Abendroth & Root Manufacturing Company succeeded in the first place in establishing the fact that they had lived up to every article of their agreement and had even done more than they had agreed to do. In the second place they succeeded in establishing the fact that they had used the best material obtainable in the market. In this connection it is interesting to note that the greatest number of breaks occurring in these Edison boilers were reported to be in the item of bolts; and as it is a natural conclusion that the greatest breakage will occur at the weakest point, it was necessary to establish by evidence the fact that these bolts were equal, if not superior, to anything to be found in the market. Specimens of the bolts were thoroughly tested and shown to be of the best material. The Abendroth & Root Manufacturing Company also showed by means of photographs the tools which they now use in the manufacture of their boilers, and they showed that the best methods of manufacture were employed in making the boilers for the Edison Company.

The Abendroth & Root Manufacturing Company succeeded in proving that the accidents were due entirely to the handling of the boilers by the Edison Company, with the object of forcing them far beyond their rated capacity, sometimes exceeding this rating by as much as 100 per cent. and over. They also showed that the Edison Company employed unskilled labor, and that these employees had instructions to keep steam up to the required pressure irrespective of any demands that might be made on the boilers, and that the whole idea was to keep the lights going which the Edison Company had contracted to supply, without regard to the personal safety of the attendants or capacity of the boilers.

Another very important point established by the evidence was that an excessive forced draft was used in order to drive the boilers to the unreasonable extent to which they were used, and evidence showed that this draft was sufficient at times to support a column of water from three to four inches in height. It was also shown that the feed water used in the boilers was very impure, and that in order to neutralize the effect of these impurities an excessive quantity of chemicals was used with the water.

One of the most interesting points developed was the production of water hammer in the tubes of these boilers, which was explained in the following manner: It is a well-known fact that every pipe or tube has a definite capacity of discharge, and when this capacity is reached no more water or steam can be delivered through an opening of such an area; so that in case a larger discharge is required, a larger tube must be used. In driving these boilers to such an excessive extent, in the course of natural circulation the water and steam passed up along the inclined tubes to the front headers, and there advanced upward into the overhead steam and water drums, from which the steam was delivered to the piping system. When the circulation reached a point equal to the capacity of the tube, of course, no more steam or water could be discharged from that upper end of the tube, but as the heat still continued to be applied around the tube, more steam was generated, and of course the pressure of this steam in the tube forced the steam and water back down the tube until it reached the rear header, and here the steam suddenly had a chance to escape upward by the course of the rear headers to the overhead steam and water drums, and the colder feed and circulating water trying to enter the lower end of the tubes from these same rear headers came in contact with the steam thus seeking passage of escape. The result was a sudden condensing of the steam, which was followed by a rush of water into the vacuum at an exceedingly high velocity, and this water rushed along the tube at about this same velocity until it reached a bend at the end of the tubes. The result was a very sudden and powerful blow there practically like that of a cannon ball, which caused the bolts to rupture in the manner above described, breaking them, in fact, so rapidly that a flow of the metal composing them at the point of rupture was impossible.

This flow necessarily would take a certain amount of time. The consequences of this sudden blow was exhibited in the

breakage of these bolts without contraction of area at the point of rupture. It was remarked during the course of the trial that it was fortunate that these boilers were composed of small headers covered by small castings known as connecting bends, and that thus the damage done affected merely these small castings, producing there local results instead of rupturing large castings, which would, of course, be attended by far more serious ruptures. Glass models were shown at court which illustrated beautifully the theory thus presented, and in such a manner as to carry conviction to the minds of the Court that this was the true theory of the disastrous occurrences. Other glass models illustrated the irresistible power of the water hammer, the force of which was sufficient to break the tubes which held the water surrounded by a vacuum.

The plaintiff brought in as an expert Professor Spangler, of Philadelphia, while the defendant brought in as experts Dr. C. E. Emery, of New York, and Prof. R. C. Carpenter, of Sibley College, Cornell University, Ithaca. Prof. W. D. Marks, of the Philadelphia-Edison Company, and Mr. Albert A. Cary, of the Abendroth & Root Manufacturing Company, also testified as experts on their respective sides.

Altogether it is a well-earned and well-deserved victory of the Root Company on which they are to be congratulated.

Improved Car-Brace Cutting-Off Saw.

The use of this machine in any freight-car shop means a saving in time and labor in the cutting of freight-car braces that should command the attention of master mechanics. With it there is no rehandling of the material, no laying out, no preparatory cutting to lengths, no waste material. The angles are cut much more rapidly and accurately.

The framing is substantial; the various shafts and arbors are made of fine steel of proper diameter, and the bearings are long and self-lubricating. The journals are ground true, all joints are planed and the tables are made of iron and adjustments made convenient. The lower saw is mounted in an automatic feeding-carriage controlled by a foot-treadle, and with provision for keeping the belt tight. A saw on top of the table at right angles to the lower saw is carried in an adjustable bearing, which allows the saw to be lowered as it is worn down in diameter. It travels in planed ways, securely gibbed to the table, and operated by means of a lever. The table is provided with adjustable fences and guide-rolls. Adjustable stops are added for holding the material against the fences properly.

A supplemental gage table is supplied, mounted on a heavy iron column. This is used for regulating the length of the braces, and is provided with an adjustable fence across the table. This fence is slotted lengthwise, and has an adjustable stop, the right angle cut by the saws having a perfect bearing against the fence and stop. Two saws eighteen inches in diameter are furnished with the machine. Two counter-shafts are provided, each carrying ten by sixteen inch T and L pulleys. This convenient and labor-saving machine is made by Messrs. J. A. Fay & Company, of Cincinnati, Ohio.

A lead pipe was recently taken up, which, it is related had carried water to a farm house for 74 years.

A Model Train.

Commencing Sunday, Jan. 5, and daily thereafter, the popular New York and Florida Short Line Limited will be resumed between New York and St. Augustine, via Pennsylvania, Southern and Florida Central and Peninsula, leaving New York at 3.20 p. m. The train will be composed of latest improved compartment cars, sleeping, dining, first-class coach and smoking cars, from New York to St. Augustine. For grandeur and solid comfort there is nothing in the world that surpasses this train. The compartment car is a model of perfection. The entire train is most elaborately furnished, and the country through which the train travels is rich in magnificent scenery, and the one day which is consumed in the trip can be spent most advantageously in taking in the beauties of nature. The announcement of the new train several years ago was one of the great achievements of the Southern Railway "Piedmont Air Line," and the public are highly grateful and have and will continue to show their appreciation to the evident satisfaction of those instrumental in reducing the time between New York and Florida to a minimum. Excursion tickets south have been placed on sale at "very low rates," and those contemplating taking a trip to the Sunny Lands should call on or address Mr. R. D. Carpenter, General Agent, 271 Broadway, New York.

The Bolea Steel Wheel Company reports business good, and all departments of its extensive works, at Scranton, Pa., running full time. The No. 2 wrought iron center wheel made by this company is winning great favor among the mechanical departments of roads in many sections of the country.

Reduced Quality Follows Reduced Price of Steel Rails.

Mr. J. F. Wallace, Chief Engineer of the Illinois Central R. R., writing in the *Engineering Magazine* for December, says that while it is true that there has been a steady and uniform decrease in the price of steel during the last quarter of a century, the average standard weight of rail for main lines has at the same time increased from 60 lbs. to 90 lbs. per yard, and the quality has materially depreciated. As an example of the deterioration that has taken place in quality, he states that during the past year he has relieved from a main track on tangents rails that weighed 75 lbs. to the yard which had been in the track only five years; whereas, on the same district and under precisely the same traffic conditions, there still remain in the track 60 lb. rails that have been in service for over 15 years, which it was not considered necessary to renew this season. While this may be an exceptional case, he considers the steel rail which was furnished by the manufacturers 15 to 20 years ago about 50 per cent. better than the rail now manufactured. This is not intended to apply to special high-class rails, which may be furnished by a few rolling mills under superior specifications, but to the ordinary rail supplied to and purchased by the majority of the railroads in the United States to-day.

A Railroad Struggle Compromised.

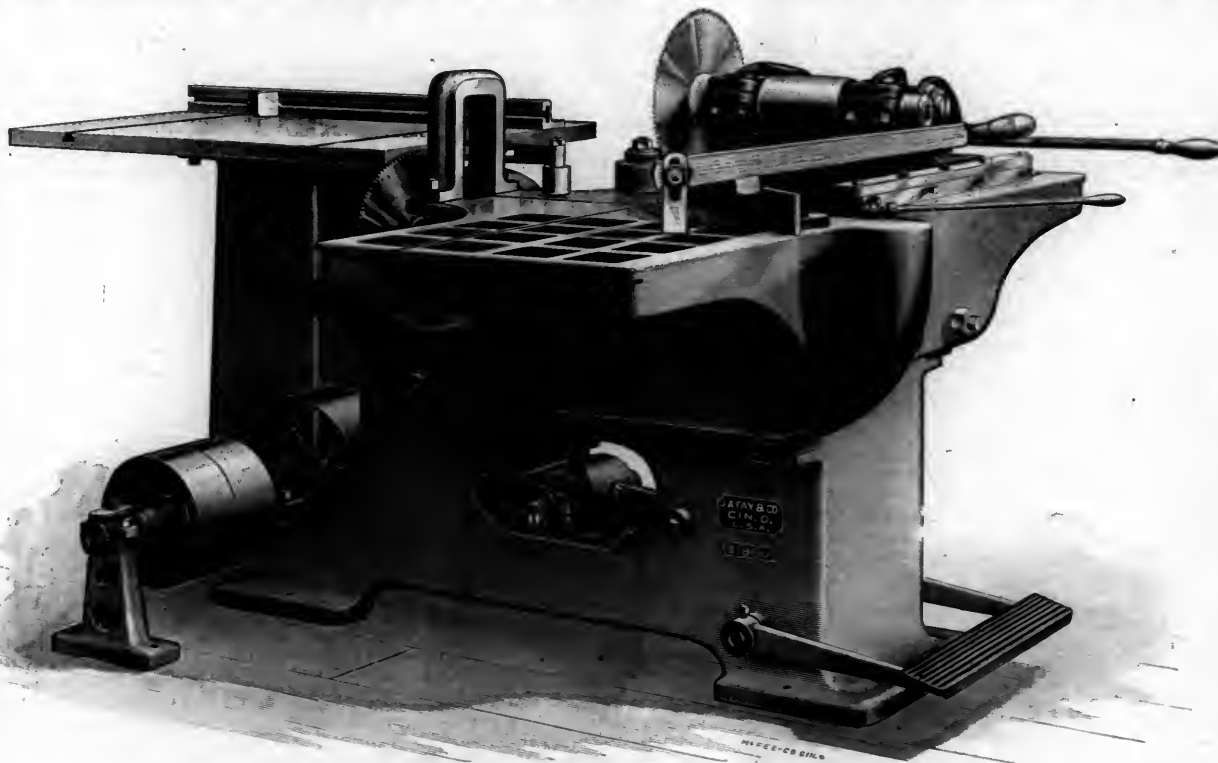
The long struggle between the Missouri, Kansas & Texas and the International & Great Northern roads for possession of the Galveston, Houston & Henderson Railroad, between Houston and Galveston, furnishing an outlet on the Gulf, has been terminated in a compromise, after being before the State and Federal courts for about three years. The terms of the compromise as agreed on provide that the M., K. & T. shall transfer to the I. & G. N. 4,999 shares of the capital stock of the G., H. & H. at the par value of \$100 a

Manhattan Elevated Railway Affairs.

According to statements made by the Auditor of the above-named company to a committee of the New York Legislature on Dec. 5, the company has 102 miles of single track. In 1895 the company paid the city of New York \$590,243 in taxes, while in 1894 \$564,300 was paid. In 1895 the company paid \$95,000 to the State of New York in taxes, and in 1894 it paid \$93,000. The gross amount of bonds outstanding is now \$46,500,000, but \$3,500,000 of these will be ordered on Jan. 1. The capital stock at present is only \$30,000,000. The gross income for the last fiscal year was \$9,397,572; the operating expenses, exclusive of all taxes, were \$5,413,964, leaving net earnings at \$3,983,608. Then there was an income from other sources amounting to \$287,134, which makes gross income \$4,270,742. The interest on the funded debt was \$2,095,722, the taxes, \$652,722, making \$2,748,694, which sum deducted from the gross income, leaves a net income to the company of \$1,522,048. For the year ending Sept. 30 last the road carried 188,072,645 passengers. The total number of passengers carried since the railway started, up to Sept. 30, is 2,410,845,497. The company has about six thousand employees, and pays engineers \$3.50 a day for nine hours' work; firemen, \$2; conductors, \$2.80, and guards \$1.85.

President George J. Gould said, when asked what he thought of building an underground railway: "I think it is possible to build an underground railway, but that it would not pay financially. It is not paying in London, where the circumstances are better than they are here." He said that in his opinion an elevated road with electric motive power would be the best system of transit in New York, and that his company was at present experimenting with electricity. He was asked:

"Have you any complaints coming in about overcrowded cars?" "Yes," he replied, "but I don't see how that can be remedied. In the morning everybody wants to go south and in the evening they want to go north. You can't stem the tide. In Third avenue, during the rush hours, we run trains on 50 seconds' headway, and I don't think they can be run safely on much less headway than



IMPROVED CAR-BRACE CUTTING-OFF SAW.

share, being one-half of the total amount of the capital stock of that company, less one share, the "Katy" retaining 4,999 shares, and the two remaining shares being placed with some party agreed upon by both the contending roads in order to secure the strict carrying out of the terms of the agreement. In consideration for this transfer of stock the I. & G. N. surrenders the ninety-nine-year lease made in 1883, by which it secured exclusive possession and control of the G., H. & H. property. The agreement further stipulates that both the International and "Katy" shall enter into a joint contract with the G., H. & H., identical in every detail for the transportation of trains, cars, passengers, tonnage etc., between Houston and Galveston. Under this amicable arrangement the two rival roads will at once begin a joint operation of the G., H. & H. track between Houston and the Gulf, and the "Katy" will be able to touch tidewater.

The evening classes at the Young Men's Institute, 222 Bowery, New York, report a large enrollment this season. One of the most popular classes is that in Steam Engineering. The enrollment in this class includes workers from all fields of the practical applications of steam, viz., firemen, engineers, machinists, etc. They are taught the fundamental principles of the science and also its latest developments. By means of textbooks, lectures and experiments, a comprehensive view is taken of the whole subject. Other subjects taught are the commercial branches, arithmetic, bookkeeping, shorthand, English grammar, and technical branches. Carriage drafting, architectural drawing, mechanical drawing, freehand drawing. Some of these require a two and some a three-year course. A new term will begin Jan. 2, 1896. Young men between the ages of 17 and 35 are allowed to enroll at any time.

that." Mr. Gould also said he was aware that complaints were being made about the lighting of the cars, and they were looking about for a better system. "A year ago we were about to adopt Pintsch gas, but electricity came into prominence and we decided to wait. If we adopted electricity as a power, of course we should want to light cars with it."

"I don't believe in municipal ownership of railways," said Mr. Gould, "and think it would prove disastrous. Government roads are never run so well as roads run by private corporations. They have tried it in Europe with their military roads, and it has proved a failure. The taxpayers have to go into their pockets every time. The Government, I think, should not go into the business."

American locomotives are now going into Europe. The ordering of 40 locomotives by the Russian Government from the Baldwin Locomotive Works, Philadelphia, Pa., leads *La Genie Civile* to say: "Already in the matter of furnishing railroad material American constructors had taken possession of the South American market and were carrying on a formidable competition against the English in their own colonies, especially in New Zealand and Australia, but it was hardly expected that they should be seen obtaining a foothold in Europe." Why not, pray? Are not American locomotives the most beautiful in design, the most nearly perfect in construction, the most reliable in function, the swiftest in motion, and the best in all essentials of all locomotives on earth? Why should European railroad-builders not have as good taste and judgment in selecting locomotives as the railroad-builders of Australia and South America? Go to Europe, as an artistic country, should buy only American locomotives, or else compel European builders to build locomotives strictly on the American models.—*Iron Industry Gazette*.

The Lake Portable Key-Seater.

The accompanying illustration shows a very useful machine made by the Lake Brothers, of No. 1645 North Tenth street, Philadelphia. As every mechanic knows, in making repairs in shops, etc., it is a very serious thing to be compelled to take down a line shaft, or any part of it, to have a key-seat cut, or if not removed from its position it is necessary to chisel the same, which is a very slow operation, and not very satisfactory when completed. Often a great deal of trouble and annoyance is experienced by having gears, pulleys, couplings and clutches work loose on the shaft when in use, usually the result of an inaccurate key-seat being cut in the shaft. With this machine it is not necessary to remove the shafting from its hangers or boxes to cut a key-seat, and in this way a split pulley or coupling can be applied very quickly, or if a solid pulley is used it is only necessary to remove the hanger or box, so as to slide the pulley on the shaft, thus saving time, which amounts to a great deal where any number of persons are employed.

Our illustration shows the machine as it appears after having cut a key-way 4 inches from the end of shaft. This machine will mill key-seats any length in shafting from 1½ inches to 4½ inches in diameter, and of widths varying from ¼ inch to 1½ inches, and any depth not exceeding ¾ inch. Each machine is furnished with six milling cutters, which by placing one or more on the spindle of the machine, key-seats the sizes mentioned above, any of which can be cut at one operation the width required. When the cutters are kept sharp the machine will mill all key-seats up to ¾ inch wide, by ¼ inch deep at one operation, but for the wider key-seats it will be necessary to go over the work two or more times, according to the depth required. The machine is provided with either automatic or hand feed while cutting, and has a dial to show the depth of cut in the shaft. The machine will mill 4 inches before it is necessary to move the base forward on the shaft. An operator can easily cut a key-seat 12 inches long, ¾ inch wide, ¼ inch deep in one hour, and other sizes in proportion.

Africa for Africans.

Mr. Robert Perry, a Chicago contractor, who has been spending two months in Johannesburg, South Africa, says: "I want to warn Americans to keep away from that part of the world. There is nothing to go there for. The climate is unhealthy, living is exorbitantly high, and the people who are there are almost in a starving condition. Negroes do all the work in the mines. The place is a desert where scarcely anything grows, and there is a water famine most of the time. Every imaginable thing is taxed heavily. Even Pretoria's own paper has printed a warning to the world to keep away from the place. The people who have lived there ten or fifteen years are away behind the times. When I told them about the motorcycle and the kinetoscope, they thought I was telling fairy tales, and would not believe me."

The Switzerland of America.

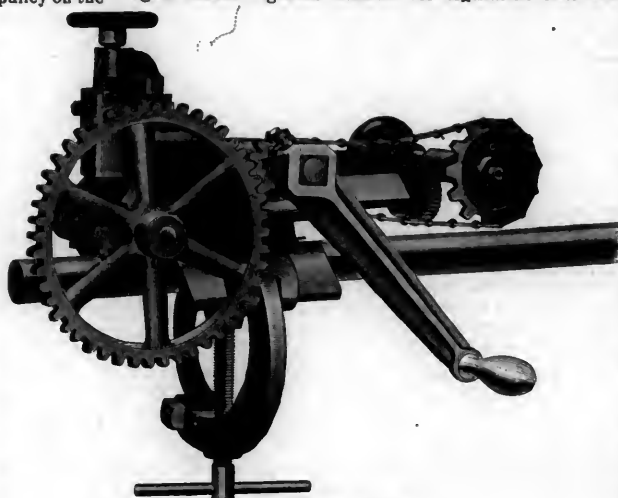
The assembly hall of the Union League, in Philadelphia, was thronged with people on Dec. 27 and 28, to see the exhibition of pictures of scenes along the line of the Lehigh Valley Railroad. The pictures were photographs by William H. Rau, of Philadelphia, made last summer. A locomotive and car, fitted up with a dark room for developing the plates and all the other appliances of a photographic studio, were placed at his disposal by the company, and the 250 or more pictures exhibited are a part of the results of his work.

The region through which the Lehigh Valley Railroad runs has often been called the "Switzerland of America" from the beauty and variety of the scenery. Many of the pictures are of scenes of which the traveler catches fleeting glimpses from the car windows as he is whirled along the Lehigh and Susquehanna rivers. Some of the pictures are of the country in the vicinity of Easton and Bethlehem, Pa., and the series of the vicinity of Mauch Chunk show the river shut in by mountains and the railroad curving in and out along the bank. But the real "Switzerland of America" is not reached until the traveler approaches Wilkes-Barre. Here glorious subjects for the artist are to be found on every side. The pictures of this region are among the most beautiful in the collection. There are pictures of Glen Summit and the beautiful Wyoming Valley, and views of forest, and mountain, and stream from Point Lookout and from Wilkes-Barre Mountain. The photographs of the collieries about Wilkes-Barre, Mahanoy City, Shenandoah and Pittston are exceedingly interesting and illustrate in a novel way Pennsylvania's great mining industry. The valley of the Susquehanna River offers an endless variety of subjects for the camera. The various views of the river between Falls Station and Towanda show conclusively that the scenery along the river is varied and characterized by a beauty that must inspire the most prosaic nature. Then come the lakes. Beechwood Lake, Shawanese Lake, Lake Ganoga, Seneca Lake, Cayuga Lake, Owaseo Lake and Hemlock Lake are all beautifully represented. One of these, Lake Ganoga, stands in a virgin hemlock forest of vast extent. The surrounding mountains are covered with a heavy growth of hemlock that man has never penetrated. Hemlock Lake is not far from Rochester, and although not as well known as some of the others, the prospects for its future are of the best. A new branch of railroad has been run to the lake from Rochester.

Safe Lighting of Mail Cars.

The Superintendent of the Railway Mail Service, Mr. Joseph E. White calls attention again, in his annual report just concluded, to the necessity of adopting safer methods for lighting mail cars. For several years the Post Office authorities have pleaded with Congress to adopt a measure forbidding the use of oil in lighting the cars in which the mails are carried. In report after report the various superintendents of the Railway Mail Service have called attention to the immense losses caused the Government by reason of mail cars and their contents being burned, either by the explosion or overturning of oil lamps when accidents happened.

Such casualties frequently occur, and, as the report mentioned fully shows, the greater number of fires arising from accidents were caused by the lamps with which the cars were lighted, and only in very rare instances by the fire from the engines. In his report Superintendent White again makes vigorous demand for legislation that will



A PORTABLE KEY SEATER.

effectually prevent the recurrence of such disasters which involve such tremendous losses. He says:

"The leading bankers, manufacturers, merchants and prominent citizens of this country are very strongly in favor of greater care in the transmission of the mails, because of the immense loss and trouble caused by their destruction in railroad wrecks, when thousands of checks and drafts are destroyed, often taking years to trace up and replace. Furthermore, the average citizen who, after all, pays the freight, has a very decided interest in the matter, from the fact that letters and mementos are often lost which can never be replaced. Every business firm in the United States is vitally interested in this question, because, apart from financial considerations, important communications and orders are lost, which cannot be duplicated and frequently can never be replaced."

Burning Liquid Fuel.

An English paper, in commenting on the burning of liquid fuel, says: Hundreds of patents have been secured for different methods of spraying and burning liquid fuel. The great secret of success seems to lie in so arranging matters that the flame will not put itself out and prevent the oil from being properly consumed. If we put a bit of flaming paper over the chimney of a lighted lamp, the paper will be extinguished by the uprush of carbonic acid from the lamp flame. In the same way, when petroleum spray is directed into a furnace high up it cannot burn because the upper part of the firebox contains little or no free oxygen, the spray is driven unconsumed through the flame, strikes the bridge or fire stone and runs down it to be burned—usually badly—below. The jet of oil should enter near the grate bars, but the precise height is a matter of adjustment, involving special knowledge not to be imparted by letter press. As regards the spraying, that is usually effected by steam, but the practice is very objectionable, because the quantity used is very considerable, and represents great waste of fresh water, which must be made up again for the sake of the boilers, at least in the case of sea-going steamers. The use of compressed air appears to be better, but it is worth while to consider whether either air or steam is needed. It might be found practicable to get rid of both by driving the oil in through very fine nozzles—needed if desirable—under heavy pressure. This device has been employed in oil engines with much success, and we do not see why it should not be made to answer for furnaces.

Low Excursion Rates.

The Southern Railway (Piedmont Air Line) has just issued a circular announcing low excursion rates to Southern cities and winter resorts. The new points to which excursion tickets are sold this winter included many prominent Southern cities. This great system penetrates every Southern state over its own rails: operates solid trains, vestibuled sleeping and dining cars, from New York to New Orleans, Jacksonville, Tampa, Atlanta, Augusta, Asheville, Chattanooga, Birmingham and Memphis. This is the route that forms the great Colonial Limited via New Orleans in connection with the Sunset Limited, the most elegant appointed train service between the Atlantic and Pacific.

The Riehle Brothers Testing Machine Company, of Philadelphia, purposes printing in a standard 6 x 9 volume, various matters pertaining to physical testing, together with such chemical analyses and other data as may be of value in determining the strength of all kinds of material. This pamphlet, beginning January, 1896, will be issued quarterly, and will be a digest of tests so arranged under appropriate headings as to make of it a ready book of reference.

There will be a receiver's sale of the entire plant of the New York Frog & Switch Company, at Hoboken, N. J., Thursday, Jan. 9, 1896. For full particulars address Mr. F. K. Day, Hoboken, N. J.

The Florida season is now fully opened up and the question of when to start and by what lines to travel is presenting itself to the Southern tourist. A pleasing choice of route is an essential feature of a railway trip. The Cincinnati, Hamilton & Dayton Railway, with solid trains, magnificent sleeping and parlor car service, quick schedules and close Cincinnati connections with the fast lines to Florida, realizes all the possibilities of modern journeying.

Dixon's Silica Graphite Paint, manufactured by the Joseph Dixon Crucible Company, of Jersey City, N. J., will be used in painting all the tin work and skylights of the Post Office Department building at Washington. A quantity will also be used on the Capitol and the District Government Building.

The Chicago Rabbeted Grain Door has been ordered on 600 new box cars now being built for the Norfolk & Western Railroad. These doors are ordered also on 500 new box cars being built for the L. N. A. & C. R. R.

Riehle Brothers Testing Machine Company have just been notified that they have received a silver medal for the excellence of their 100,000-pound automatic and autographic testing machine exhibited at the Atlanta Exposition. This is the highest award.

The Hills & Jones Co., of Wilmington, Del., has just issued an exceedingly attractive catalogue, presenting large handsome photo-engravings of the special line of machine tools made by this company for working iron and steel plates, bars and structural shapes. The pamphlet is original in design and very artistic.

Messrs. T. Shriver & Co., of 333 East Fifty-sixth street, New York City, are Iron and Brass Founders and Machinists who make large castings in green or dry sand—being fully equipped for the purpose. A feature of their business is the making, on special molding machines, gear wheels of any diameter, face or pitch; no pattern being required from the party ordering; and fly wheels and pulleys of any diameter, or face, also without the necessity of a pattern. For castings requiring great strength they use a special mixture of iron, which they have developed in the course of their experience. They are also manufacturers of overhead traveling cranes particularly adapted to use in power rooms of street electric and cable roads, and they invite correspondence on the subject.

Our Directory

OF OFFICIAL CHANGES IN DECEMBER.

We note the following changes of officers since our last issue. Information relative to such changes is solicited.

Atchison, Topeka & Santa Fe.—Master Mechanic W. E. Symons, of Raton, N. Mex., has resigned.

Birmingham, Sheffield & Tennessee River.—General Manager Philip Campbell has resigned and is succeeded by Samuel Hunt.

Canadian Pacific.—William Apps is appointed General Master Car Builder.

Chicago & Eastern Illinois.—Assistant Superintendent M. P. Albert Griggs has resigned.

Chicago, Burlington & Quincy.—General Manager W. F. Merrill has resigned, and is succeeded by W. C. Brown.

Choctaw, Oklahoma & Gulf.—G. F. Huggins is appointed General Superintendent, vice J. D. Bradford, resigned.

Cincinnati, New Orleans & Texas Pacific.—Master Mechanic I. W. Fowle, of Somerset, Ky., has resigned.

Cleveland, Cincinnati, Chicago & St. Louis.—Assistant General Manager C. E. Schaff is appointed General Manager.

Erie.—W. F. Merrill becomes Second Vice-President in charge of the Operating and Maintenance of Way Departments.

Florida East Coast.—G. A. Miller is appointed Master-Mechanic.

Grand Trunk.—General Manager L. J. Seargeant retires from that position and is succeeded by Charles M. Hays.

International & Great Northern.—W. C. Peterson is appointed Foreman of Motive Power and Car Department. Office at San Antonio, Tex.

Macon & Birmingham.—J. R. Lane is appointed Superintendent.

New England.—T. W. Adams is appointed Master Car Builder, office at Norwood, Mass.

Panama.—General Superintendent A. L. Rives has resigned.

Pennsylvania.—Richard Durborow is appointed Master Mechanic of the West Philadelphia shops, vice M. Garrett, resigned.

Poughkeepsie & Eastern.—E. C. Osborn is appointed General Manager.

Southern Pacific.—R. L. Herbert is appointed Master Mechanic at Victoria, Tex., vice I. R. Garnott, transferred.

St. Louis, Belleville & Southern.—J. W. Karner is appointed General Manager.

Southern Railway.—T. S. Inge is appointed Master Mechanic at Burlington, N. C.

Terminal Association of St. Louis.—E. P. Bryan is appointed General Manager.

Wisconsin Central.—A. D. Allibone is appointed Purchasing Agent, vice J. A. Whaling, resigned.

Employment.

A Master Car Builder and Mechanical Draughtsman, with a large experience in designing and constructing all kinds of cars, is open for an engagement. Best of reference furnished. Apply to office of NATIONAL CAR AND LOCOMOTIVE BUILDER.

AMERICAN ENGINEER CAR BUILDER AND RAILROAD JOURNAL.

FEBRUARY, 1896.

CONTENTS.

ILLUSTRATED ARTICLES:	Page.	Page.
The Standard Locomotives of the Grand Trunk Railway Construction and Maintenance of Railway Car Equipment, II	20	21
The Solignum Mixed Boiler	22	23
A High-Speed Belt Governor for Corliss Engines	26	27
The Most Advantageous Dimensions for Locomotive Exhaust Pipes and Smoke-Stacks	27	28
Gold's Improved Sealed Jet System of Hot Water Circulation	31	32
The Brownell Automatic Governor	31	32
The Diamond Steam Trap	32	33
EDITORIALS:		
The Rules of Interchange	24	25
The New York Electrical Exhibition	24	25

Spitting	24
Large Locomotive Grates versus Small Ones	24
MISCELLANEOUS:	
Paragraphs	17
Notes on Russian Engineering	18
Means Adopted for Saving Oil Fuel in a Large Oil Refinery	22
Trade Catalogues	25
The American Machinery Circular of Inquiry on Freight Car Door and Attachments	25
Personals	26
Queen Victoria's Cars	26
The Holding Power of Lag Screws	31
Improved Freight Service South	32
Big Verdict Against Pullman	32
Our Directory	32

The Erie Railroad is to build five engines at its own shops.

It is stated that the Wabash road will soon be in the market for 1,000 freight cars.

The Lake Shore & Michigan Southern road will soon be in the market for 1,000 coal cars.

The Madison Car Company has been given an order by the Union Pacific, Denver & Gulf for two derrick cars.

The Duluth, South Shore & Atlantic has prepared specifications, and bids are asked for the building of 500 new ore cars.

M. L. Hinman, President of the Brooks Locomotive Works, Dunkirk, N. Y., has recovered from a long and serious illness.

The Pennsylvania Railroad has fitted up a 60-foot car for the purpose of instructing trainmen in the care of steam heating apparatus.

A lift span bridge, 421 feet long, will probably be built across the Missouri River at Kansas City, from the designs of Mr. J. A. L. Waddell.

The Chicago & Northwestern Railway is rebuilding docks at Escanaba, Mich., making 226 pockets. The work will be completed and the docks in readiness by the opening of navigation.

The Maine Central Railroad is using large quantities of Nova Scotia coal, and the Boston & Maine is now trying it on its passenger locomotives, having already extensively introduced it on its freight engines.

Underground electric locomotives at the Marks Colliery in Pas-de-Calais, France, each weighing three tons, draw 30 corves, holding 15 tons of coal, at the rate of 10 miles an hour, thus taking the place of 30 horses.

The Lake Michigan Car Ferry Transportation Company, which transports freight cars on barges between Peshtigo, Wis., and South Chicago, has ordered two additional floats to be ready for service at the opening of navigation in the spring.

The Overland Fruit Despatch, of San Francisco, has placed an order with the Madison Car Company for 100 refrigerator cars, to be built under the Lorenz patents. The cars will be 36 feet long and will be equipped with the Gould couplers.

The estimate of the production of pig iron in the United States is 9,387,639 gross tons. Unless Great Britain shall greatly exceed any previous year's production of pig iron, this is the largest year's production of pig iron of any country in the world.

An Englishman has invented an automatic headlight which so adjusts itself as to throw its rays along the rails on curves. The casing is pivoted to boiler and there is a connection to the frame so that the light turns when the engine enters a curve.

The North Sea-Baltic Canal seems to have stood the test of the first serious frost better than many had anticipated. While ice had almost put a stop to navigation in the Shen and Hadersleben firths, sailing vessels could pass through the canal without any impediment whatever.

An experimental car is to be fitted with electric motors and tested on the New York and Brooklyn Bridge. The trial is to last for thirty days and, if at the end of that time it proves satisfactory, it will be retained in service. It is to be used for switching only, the cable being retained for the hauling of trains.

The new shops of the Atchison, Topeka & Santa Fe at La Junta, Colo., east of Pueblo, are now about completed, and the new machinery is being put in place under the direction of George W. Smith, Master Mechanic of the Topeka shops. The shops are small, but are unusually well built, and have a good modern equipment of tools.

The premium system of rewarding engine drivers in England for saving coal seems likely to fall into ill-repute. A man is awarded £10 at the end of the year if he has not consumed more than a certain number of pounds of coal per mile, and when a driver sees by the coal sheet that his consumption is too high, he deliberately sets himself to lose time.

The Iron Trade Review recently published a tabular statement of the output of iron ore from the mines of the Lake Superior region during the past forty years. The grand total amounts to 97,556,866 tons. The greatest output for any one year was in 1895 when it was 10,429,037 tons, of which 5,192,504 tons came from the recently opened Mesabi Range.

The agreement for the construction of the Jura-Simplon tunnel has been definitely signed by the representatives of the Italian and Swiss governments. The termini fixed upon are Brigue, in the Valley of the Rhone, and Ossola, in Italy. Instead of a single double-track tunnel, there will be two single-track tunnels, though only one will be built at first. It is expected that the work will be completed in five years and a half.

On Jan. 6 the Southern Pacific threw open for business the new iron drawbridge across the San Joaquin River near Lathrop, abandoning the old structure. The new bridge was made by the Phoenix Bridge Co., of Philadelphia, and put in place by the Southern Pacific maintenance of way department. It has a total length of 477 feet, the draw span being 200 feet long, the south approach 62 feet and the two northern approach spans 108 and 107 feet long respectively.

During the year 1895 the Baldwin Locomotive Works built 401 locomotives. The output is about 28 per cent. in excess of that of the previous year, when but 313 locomotives were built, and about 52 per cent. of the product of 1893, when 763 locomotives were sent out. Of the 401 locomotives built during the past year, 163 were for export. There are now in hand orders for 90 engines. Of the number 20 constitute the balance of the order placed some months ago by the Russian Government. These 20 engines are now about ready for shipment.

The Pittsburgh Locomotive Works are now quite busy building new engines and on repair work. The shops have an order from the Pittsburgh & Lake Erie for ten 10-wheel freight engines with 18-inch by 24-inch cylinders, which will be larger than any now used by that company. Recently a number of 10-wheel freight engines have been completed for the Lake Shore, and three passenger engines and three switching engines for the Cincinnati, Hamilton & Dayton. A number of freight engines have been rebuilt for the Wheeling & Lake Erie, the Pittsburgh & Western and other roads.

Notwithstanding the fact that narrow gage railways have not been a success in this country, there are some 1,550 miles of these light railways in France. But, if reports speak true, they are not proving to be a very profitable investment to the government, who has guaranteed the interest on the stock for a greater portion of the mileage. Taking the lines as a whole, there was a small profit on the working during the first six months of the year, amounting to about \$35 per mile. This is not a result which would allow the lines to be operated as a purely commercial undertaking, but the interest on the shares being guaranteed by the Government, the stockholders can view the situation with equanimity.

The French Ministry of Public Works has recently addressed a circular to the various French railroads with regard to some of the complications arising from the fact that enginemen are paid premiums for time made up. It is believed that certain dangers follow the custom of giving such premiums, because the enginemen are tempted to run too fast when they have lost time. These dangers are modified, it is true, by the premiums for fuel saving and by the rules fixing the maximum speeds. It is thought important to avoid excessive speeds, and yet it is no less important to avoid delays, which disarrange the traffic and cause complaints from the public, and which are often the cause of accidents. The railroad companies are requested to make a study and report concerning the system of premiums, both for time gained and for fuel saved, in their relative effects, and also to consider and report upon the practicability of a general use of registering speed records.

Mr. Clement E. Stretton, who may be called the railroad historian, calls attention in the *English Mechanic* to the fact that in some of our American passenger engines with large Wootton fireboxes the engineer is located over the driving wheels, and the fireman, while at work, stands on the tender, and commenting thereon says:

"It is a well-understood fact, both in America and in England, that practically the duties of the firemen are so great with express trains that they can give very little attention to looking out; and as the guards are so fully occupied with duties in their vans, in practice it comes to this—that the driver must take the whole 'lookout' upon himself.

"The time will no doubt come (perhaps after an acci-

dent) when a man will be appointed to keep a lookout and nothing else."

It is hoped that Mr. Stretton's anticipation of an accident from this cause may not come true although it must be admitted that "in that direction danger lies."

The Railroad Gazette states that the Beech Creek Railroad for the year ending with June last had the heaviest average freight trainloads and at the same time the lightest passenger trainloads that we have ever seen reported. That it is a freight road is shown by the fact that for its 187 miles of railroad worked it has 2,876 freight and service cars and only 11 passenger cars, and that it is essentially a coal road by the further fact that of every 100 tons carried 94 were coal. The average trainloads last year were 14 passengers and 575 tons of freight. Substantially all of the freight goes in one direction; there was but 1 ton westbound to 55 eastbound, so that the trainloads taken out must have averaged 1,150 tons. The economy of the heavy loads, and the costliness of the light ones; are both emphatically shown by the earnings per train mile, 38 cents for passenger trains and \$2.31 for freight trains, although the average rates were 2.58 cents per passenger mile and only 0.38 cent per ton mile. The latter would seem to be ruinously low, but the road earned not only its fixed charges but a dividend of 4 per cent. on its capital stock and had a small surplus left.

Among the most recent and novel applications of wire, attention is drawn in *Hardware* to the wire flywheel lately erected at the Mannesmann Tube Company's works, Germany, and especially notable, in view of the well-known fact that heavy flywheels, driven at high velocities, present such dangers of breaking asunder from the great centrifugal force developed. The wheel at the factory mentioned is described as a cast-iron hub or boss, to which are attached two steel plate disks, or cheeks, about 20 feet in diameter. The peripheral space between the discs is filled with some 70 tons of No. 5 steel wire, completely wound around the hub, the tensile resistance thus obtained being found to be far superior to that of any casting. This huge flywheel is driven at a speed of about 240 revolutions per minute, or a peripheral velocity of 2.8 miles per minute, or approximately 250 ft. per second, which is said to be nearly three times the average speed of any express train in the world. For such a constructed flywheel the length of wire is estimated at about 250 miles. The use of paper is also regarded with favor for large flywheels, the tensile strength of paper being enormous, and it is quite possible that some of the new big wheels will be built up with a paper rim.

Professor Arnold, of the Sheffield (England) Technical School, is carrying out a series of experiments which promise to have an important bearing on the future of the steel trade. Hitherto, as is well known, steel makers have had to rely upon the chemical analysis of steel for determining its composition; but practice has shown that two steels may have exactly the same chemical composition and yet one be tough and strong and the other rotten. The reason of this was a mystery until the aid of the microscope was brought to bear upon it. The difficulty has been how to prepare the samples for the microscope, and, as the result of tedious research, Professor Arnold has solved the problem, and has reduced the preparation of samples of steel to a system so easy that it can be carried out in an ordinary steel works' laboratory. The microscope has shown that steel must no longer be regarded as a homogeneous substance, containing the constituent elements discovered in iron, but that steel is more allied to geological structure, or, as Professor Arnold puts it, "steel is an igneous rock made up of crystals of pure iron, of carbide of iron with inter-crystalline spaces filled with the compounds of the constituents of steel." This is quite a new theory, and opens up a wide field of practical information for steel makers.—*Locomotive Engineer and Fireman's Journal*.

The Chicago Main Drainage Canal is to-day probably the most interesting engineering work being carried on in the world, and is an interesting exposition for contractors' machinery. The visitor to this canal is at once impressed by the great number of traveling cableways. As built by the Liggerwood Manufacturing Company, of New York, they are to be found on nearly all the rock sections on the canal. On section two, McArthur Bros. use two cableways; on section three, the Des Plaines Consolidated Company use four; on section four, McArthur Bros. use two; on section five, the Quailie Consolidated Company use two; on section six, Mason, Locher & Williamson use four; on section seven, Locher, Harder & Williamson use one; on section eight, Mason & King three, and Locher, Harder & Williamson two. The only reason why about ten more cableways were not installed on this work was because the traveling cableway was not perfected in time. It is a fact that cannot be controverted, however, that since the traveling cableway demonstrated its present capacity no other hoisting and conveying machine was sold on the canal. One cableway was used on the river diversion work, and is now no longer used. However, the balance, 19, can be seen in daily operation—in fact, working day and night. The traveling cableway is capable of handling 600 cubic yards of rock in place per day of 10 hours, and any capacity short of that is due to the difficulty of loading the skips.

Notes on Russian Engineering.*

BY CHARLES HYDE.

At the station at which we crossed the frontier from Germany to Russia, called Eydkunnen on the German side and Virballen on the Russian side of the line, the gage of the railroad changes from the standard gage of 4 feet 8½ inches, which prevails throughout Holland and Germany, to 5 feet, the standard gage of the Russian roads. As this railroad is regarded as a means for the transportation of troops rather than passengers or merchandise, this change of gage is intended to prevent any sudden invasion from either side, the inconvenience of the change as regards the commercial use of the railways being completely ignored, the military character of this railroad in particular being still further emphasized by the fact that it runs in almost a straight line from the frontier station of Virballen to St. Petersburg, except where necessary to connect with a for tress or military station, while important trading towns on the Baltic Sea and Gulf of Finland are reached only by branches or not at all.

The Russian cars of the first-class are commodious and comfortable, being constructed on the same plan as those largely used in Germany, viz., with a corridor running along one side, and private rooms connecting with this corridor running across the car. The extreme width of the car being 10 feet, allows for a corridor of about 2 feet 6 inches wide, and a room 7 feet long inside measurement. I may mention that on most of the roads there are four classes, so that one has plenty of choice as regards accommodation.

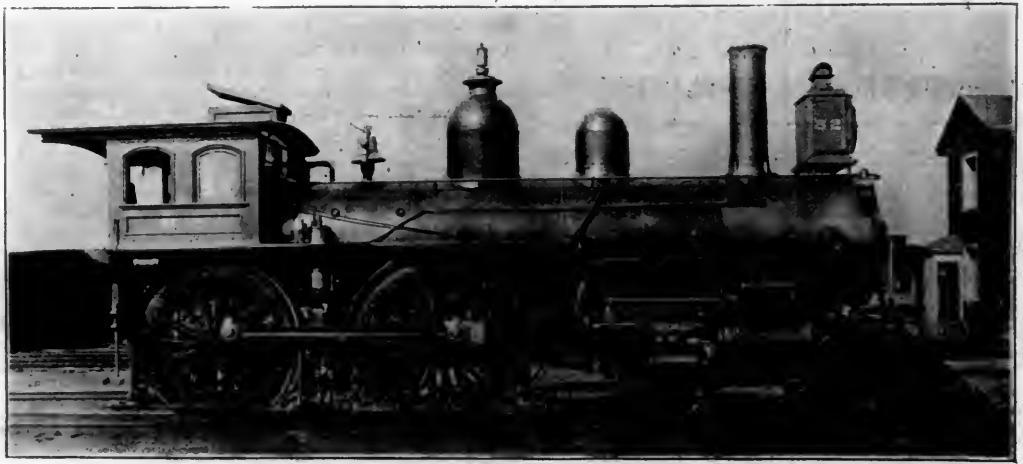
The Northern railroads use wood for the most part as fuel, which, though plentiful and clean, has the drawback inherent to a fuel of low calorific value, that the power developed is small in proportion to the weight consumed, and, consequently, the speed of the trains is slow, averaging about 25 miles only per hour. The stoppages made, too, are rather frequent, and to one anxious to get through, appear inordinately long; but as the trains do not carry dining or buffet cars, a stop of from 30 to 45 minutes about meal times is appreciated, especially as the buffet arrangements at the stations are first-rate.

Many of the saints' days, too, are observed by closing the stores and sometimes the works, so that it is always advisable in making arrangements ahead for visiting works, picture galleries or stores, to make careful inquiries beforehand. It is also the custom, which seemed curious and just a little ridiculous, to have a shrine in each department of a works—the Bessemer open hearth rail mill, hammer shop, machine shop, etc., each having its shrine to its patron saint right in the midst of the smoke and dust of the mill; and no plant can be operated unless these shrines are provided, at least in St. Petersburg. The government also insists upon the operators of a plant providing baths, hospitals and dwellings for their employees unless the works are situated in a large city, when the latter requirements may be dispensed with.

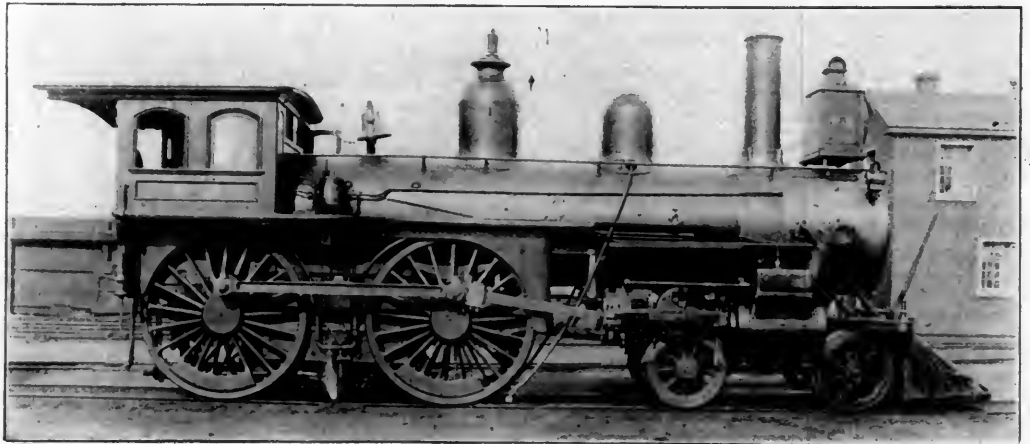
Although the neighborhood of St. Petersburg has very few natural advantages as a manufacturing center, there are a number of important industries carried on there, principally in the hands of the government or engaged in work for the government. Among the former there are the government glass and china factories; a large plant for the manufacture of playing-cards, of which the government has a monopoly; and the ship-building yards, from which the largest ironclad in the Russian Navy was launched during our stay. Among private concerns engaged in government work there are the Poutilof, Nevskii, Alexandrovsky and others. The first three are steel works, and each of them was visited.

At the largest of these, the Poutilof works, they employ about 7,000 men, have a Bessemer and open hearth department, and manufacture rails, plates, beams, angles, channels, axles, tires, bars and general merchant iron. In addition to this they build locomotives, torpedo boats, gun carriages, bridges and buildings, and also have a special department for the manufacture of projectiles, which department no visitor is allowed to see. Some of the product, however, was exhibited—among other things a solid shot which had passed through an armor plate, the point of the shot being practically as good as when fired.

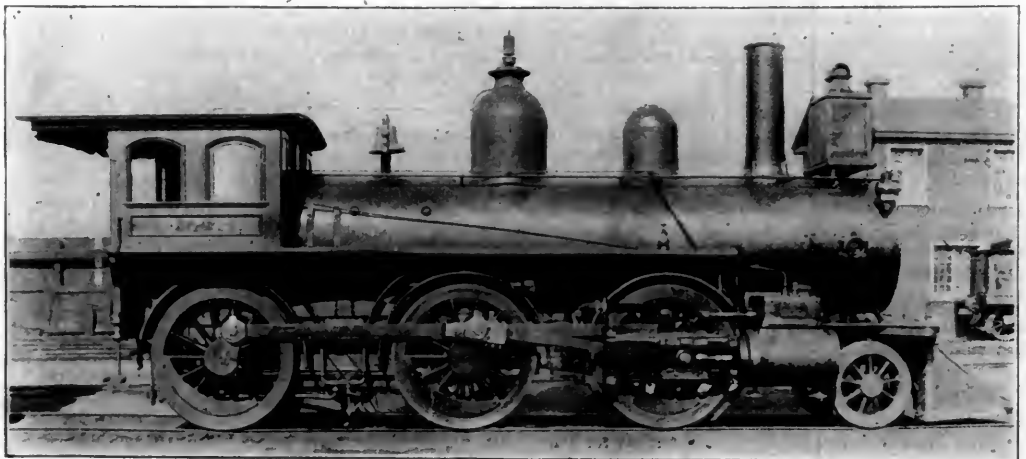
The whole of their raw material is imported; principally from England, and a six months' supply of pig, coke and coal must be stocked before the winter sets in. The duty on everything is high, which, together with freight, makes coal cost from



Express Passenger Locomotive with 18-inch by 24-inch Cylinders.



Express Passenger Locomotive with 18-inch by 26-inch Cylinders.



Mogul Freight Locomotive with 18-inch by 26-inch Cylinders.

Double Ended Suburban Passenger Locomotive with 17-inch by 22-inch Cylinders,
STANDARD LOCOMOTIVES OF THE GRAND TRUNK RAILWAY.

* Abstract of a paper read before the Engineers Society of Western Pennsylvania.

\$4.40 to \$5 per ton, and coke \$6.80 to \$7.50 per ton, and pig iron \$27 to \$28 per ton.

The Bessemer department contains two 4-ton vessels, three iron-melting cupolas and one spiegel cupola. The spiegel is tapped directly into the pouring ladle and not into the vessel; hydraulic pressure used for cranes, tilting, etc., is about 300 pounds per square inch. The open hearth department contains twelve 10-ton furnaces in a straight line, having a casting pit extending the full length, the ladles being carried on trucks extending across the pit, and running on rails laid on either side. The molds and ingots in this department are handled by traveling steam jib cranes, which seem to answer the requirements very well. Ingots for rails are bloomed down on a reversing mill in 10 passes to an 8-inch bloom, which is transferred on a buggy to a three high rail mill, and finished in 11 more passes. The capacity of this mill is about 200 tons per day, all the work of drawing and charging the furnaces, transferring and manipulating being done by hand. Labor-saving appliances are but little used in any of the Russian mills, especially in St. Petersburg, as labor is cheap in spite of the high tariff on everything—common labor being paid about 40 cents a day and skilled labor from \$1 to \$1.50.

The finished product of both the rail and structural mills looked first class, in fact it must be good to pass the very rigid government inspection, while the steel castings which they were making to take the place of forgings in gun carriages and locomotive construction equaled anything of the kind I ever saw.

The plate mill department is rather old-fashioned, having been built 15 or 20 years ago; the widest plate they could roll would be about 80 inches, I should judge; and in this department, as elsewhere, the number of men employed appeared excessive for the amount of material turned out as compared with our modern mills.

In the locomotive shops a great deal of new machinery had been recently added, and the general equipment was fairly good, but too crowded. Overhead cranes, some operated by steam, some by ropes and some by electricity, handled the material in the smith, machine, hammer or erecting shop, as the case may be, and the flanging and riveting work on the locomotives turned out was first-class in every respect. The government inspection was not only rigid, but absurdly arbitrary in some respects, though any one who has had much to do with government work knows perfectly well that unreasonable requirements and arbitrary inspection is not confined by any means to Russia.

The compound type of locomotive seems to be coming into very general favor, there being several different arrangements in use, though the favorite type appeared to be with the high pressure on one side and low on the other.

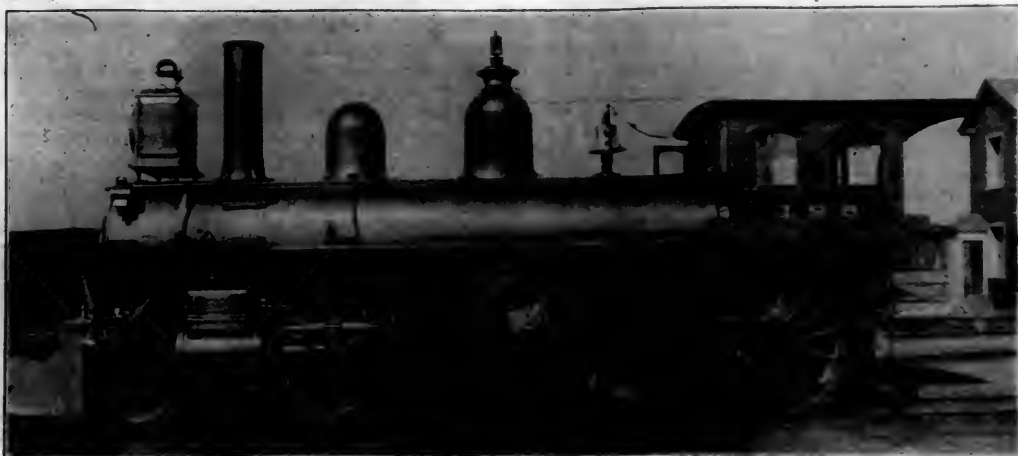
In the St. Petersburg mills, for the most part, the mill engines are of the non-automatic type, while as to boilers, I noticed in the Poutilof works, alone, boilers of the modified Babcock & Wilcox, the Lancashire, Cornish, horizontal tabular locomotive and plain cylinder type, many of these boilers being fired by the waste heat from heating furnaces.

At the "Nevski," another large works on the Neva, above St. Petersburg, there are two open-hearth furnaces of the acid type, as are all those at the Poutilof, and here also they build torpedo boats and locomotives. As illustrating the extreme rigidity of the government inspection I was informed that out of 200 plates submitted to the inspectors for the artillery department only 24 were accepted, the rest being rejected principally on tensile strength and ductility test. Sixty plates were ordered from the Belgian firm of Cockrill & Co., in order to complete their contract, and out of these 60, 48 were rejected.

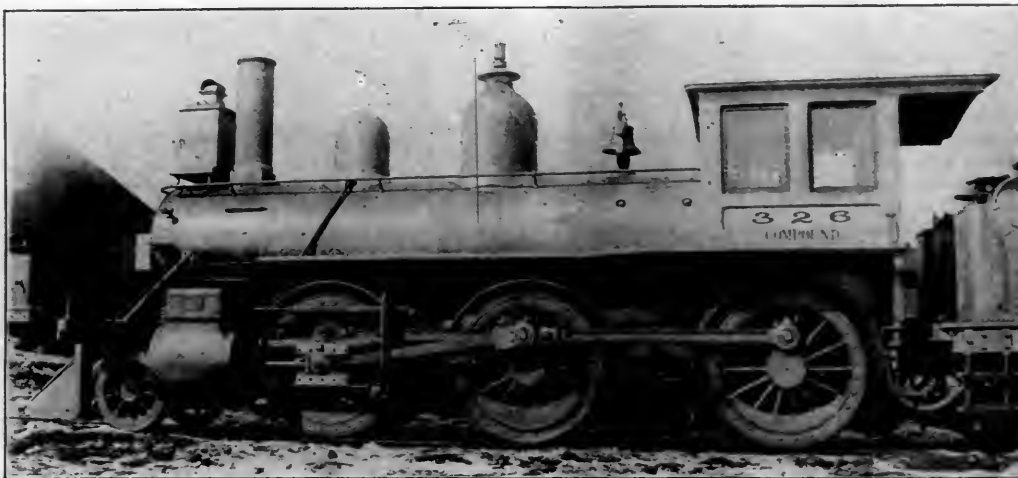
At the Alexandrovsky works, the principal output of which consists of plates and structural material, they have seven open-hearth furnaces, of which six are operated by the basic process. The metal is tapped directly from the furnace into the moulds, they being set on a revolving table in a small circular pit and brought alternately under a fixed funnel.

The object of this arrangement was, presumably, to save expense for pits, cranes and ladles. What the effect would be if the furnace broke out, as furnaces sometimes will, can be readily imagined by any one familiar with open-hearth practice. It is bad enough where you have a clear pit and good crane capacity without having a lot of mechanism in the pit, and cranes capable only of handling moulds and ingots to depend upon.

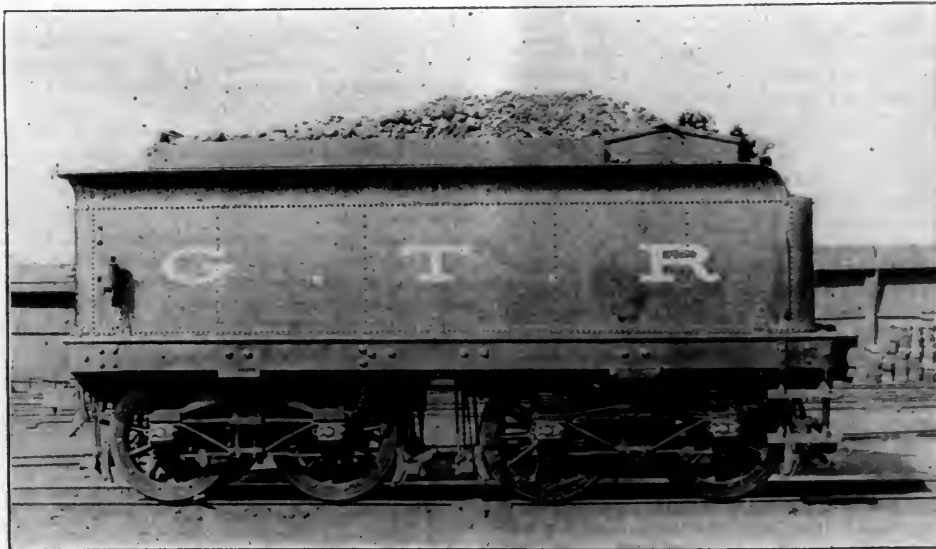
For rolling their plates they have a reversing mill operated by a three-cylinder engine, and all the plates are passed through straightening rolls as they come from the mill. The result is a very fine-looking plate of smooth surface and free from buckles. Very little handling is done here by mechanical means, as many as 17 men being



Light Passenger Locomotive for Local Service with 17-inch by 22-inch Cylinders.



Experimental Compound Locomotive of the Rhode Island System.
STANDARD LOCOMOTIVES OF THE GRAND TRUNK RAILWAY.



Standard Tenders Used on the Grand Trunk Railway.

required to draw a 5,000-lb. ingot from the heating furnace and take it to the rolls.

At Moscow, at the Gougou works, the arrangement of the open-hearth plants struck me much more favorably than did that of the St. Petersburg works, though, of course, the latter plants were older. At the Gougou works the furnaces, two in number, were of about 30 tons capacity each, with plenty of room both on the side of the charging floor and on the pit side, which was also properly equipped with hydraulic cranes. Crude petroleum from the Caspian Sea, brought up the Volga and Oka rivers in bulk in covered barges, is largely used for fuel at these works both for heating and boiler purposes, but it is not used in the open-hearth furnaces, nor did the method of using it seem the most economical. At the end of the furnace, and on the outside, the oil is allowed to fall in drops into a shallow iron trough, where it is ignited and is drawn by natural draft into the furnace. At these works, too,

they have recently put in some compound automatic engines built in England; have a good modern mill, and well-equipped nail, spike and wire factory. For this class of work they can compete successfully with other districts, but for heavy products they are handicapped on account of the high freights on all raw material. For fuel they are dependent upon coal and coke from England or Germany, or oil from the Caspian, a distance of some 1,500 miles, while much of their pig iron is either imported or comes from the Urals, a distance of a thousand miles.

As regards oil, too, all this distance is against the stream, and the Ural pig must come against the stream for at least half the distance, and I know from personal experience what pulling against the stream in the Volga means. During half the year, too, the rivers are not navigable on account of the ice.

Although there is an abundant supply of rich ore in the Ural Mountains, it is impossible to smelt it in large quanti-

Notes on Russian Engineering.*

BY CHARLES HYDE.

At the station at which we crossed the frontier from Germany to Russia, called Eydkunnen on the German side and Virballen on the Russian side of the line, the gage of the railroad changes from the standard gage of 4 feet 8½ inches, which prevails throughout Holland and Germany, to 5 feet, the standard gage of the Russian roads. As this railroad is regarded as a means for the transportation of troops rather than passengers or merchandise, this change of gage is intended to prevent any sudden invasion from either side, the inconvenience of the change as regards the commercial use of the railways being completely ignored, the military character of this railroad in particular being still further emphasized by the fact that it runs in almost a straight line from the frontier station of Virballen to St. Petersburg, except where necessary to connect with a for tress or military station, while important trading towns on the Baltic Sea and Gulf of Finland are reached only by branches or not at all.

The Russian cars of the first class are commodious and comfortable, being constructed on the same plan as those largely used in Germany, viz., with a corridor running along one side, and private rooms connecting with this corridor running across the car. The extreme width of the car being 10 feet, allows for a corridor of about 2 feet 6 inches wide, and a room 7 feet long inside measurement. I may mention that on most of the roads there are four classes, so that one has plenty of choice as regards accommodation.

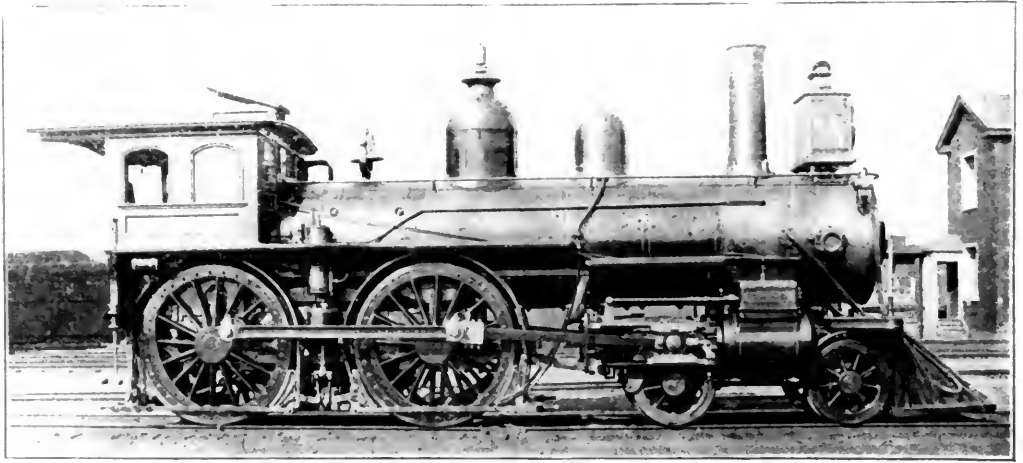
The Northern railroads use wood for the most part as fuel, which, though plentiful and clean, has the drawback inherent to a fuel of low calorific value, that the power developed is small in proportion to the weight consumed, and, consequently, the speed of the trains is slow, averaging about 25 miles only per hour. The stoppages made, too, are rather frequent, and to one anxious to get through, appear inordinately long; but as the trains do not carry dining or buffet cars, a stop of from 30 to 45 minutes about meal times is appreciated, especially as the buffet arrangements at the stations are first-rate.

Many of the saints' days, too, are observed by closing the stores and sometimes the works, so that it is always advisable in making arrangements ahead for visiting works, picture galleries or stores, to make careful inquiries beforehand. It is also the custom, which seemed curious and just a little ridiculous, to have a shrine in each department of a works—the Bessemer open hearth rail mill, hammer shop, machine shop, etc., each having its shrine to its patron saint right in the midst of the smoke and dust of the mill; and no plant can be operated unless these shrines are provided, at least in St. Petersburg. The government also insists upon the operators of a plant providing taverns, hospitals and dwellings for their employees unless the works are situated in a large city, when the latter requirements may be dispensed with.

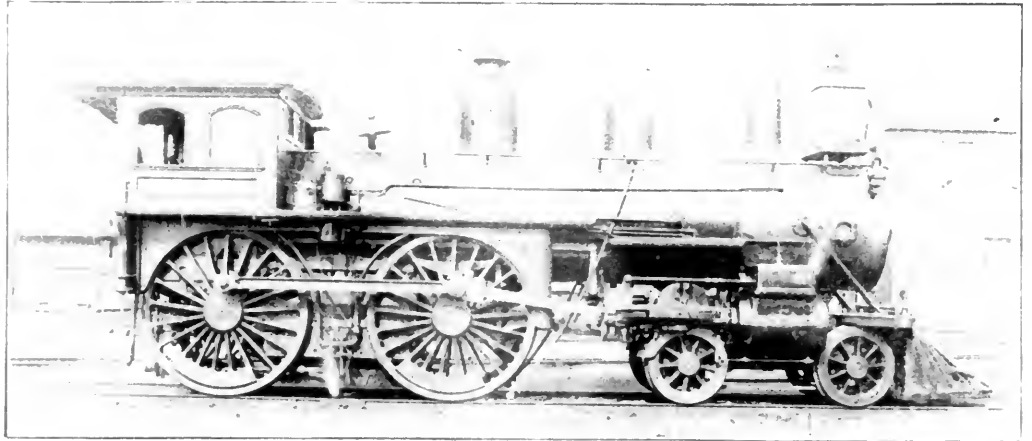
Although the neighborhood of St. Petersburg has very few natural advantages as a manufacturing center, there are a number of important industries carried on there, principally in the hands of the government or engaged in work for the government. Among the former there are the government glass and china factories; a large plant for the manufacture of playing-cards, of which the government has a monopoly; and the ship-building yards, from which the largest ironclad in the Russian Navy was launched during our stay. Among private concerns engaged in government work there are the Poutilof, Nevskii, Alexandrovsky and others. The first three are steel works, and each of them was visited.

At the largest of these, the Poutilof works, they employ about 7,000 men, have a Bessemer and open hearth department, and manufacture rails, plates, beams, angles, channels, axles, tires, bars and general merchant iron. In addition to this they build locomotives, torpedo boats, gun carriages, bridges and buildings, and also have a special department for the manufacture of projectiles, which department no visitor is allowed to see. Some of the product, however, was exhibited—among other things a solid shot which had passed through an armor plate, the point of the shot being practically as good as when fired.

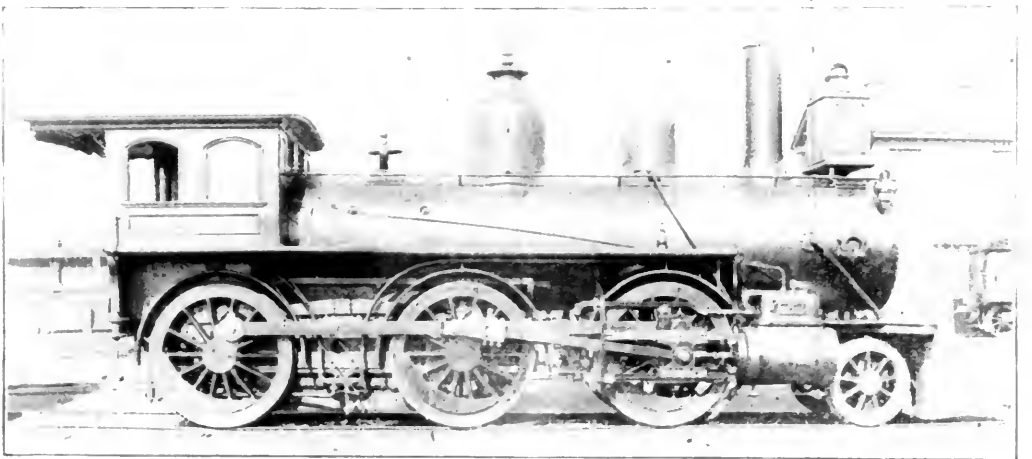
The whole of their raw material is imported, principally from England, and a six months' supply of pig, coke and coal must be stocked before the winter sets in. The duty on everything is high, which, together with freight, makes coal cost from



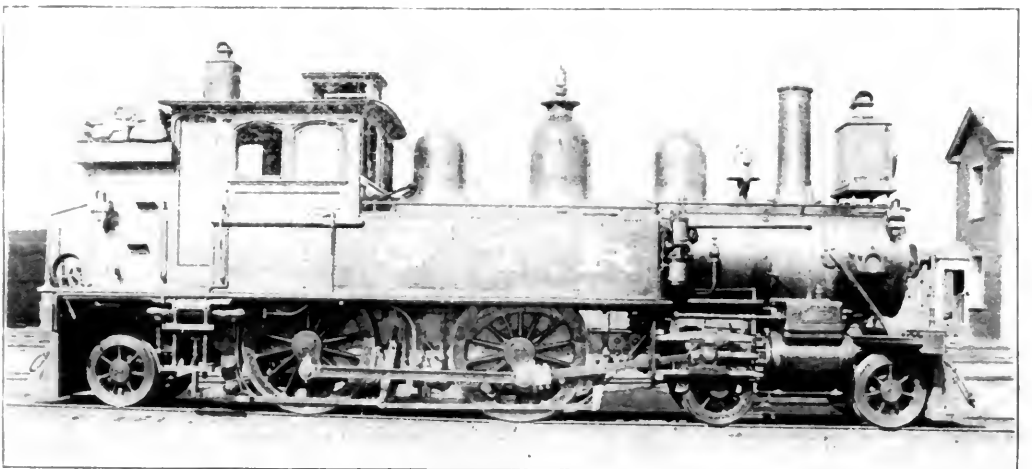
Express Passenger Locomotive with 18-inch by 24-inch Cylinders.



Express Passenger Locomotive with 18-inch by 26-inch Cylinders.



Mogul Freight Locomotive with 18-inch by 26-inch Cylinders.

Double Ended Suburban Passenger Locomotive with 17-inch by 22-inch Cylinders.
STANDARD LOCOMOTIVES OF THE GRAND TRUNK RAILWAY.

* Abstract of a paper read before The Engineers Society of Western Pennsylvania.

\$4.40 to \$5 per ton, and coke \$6.80 to \$7.50 per ton, and pig iron \$27 to \$28 per ton.

The Bessemer department contains two 4-ton vessels, three iron-melting cupolas and one spiegel cupola. The spiegel is tapped directly into the pouring ladle and not into the vessel; hydraulic pressure used for cranes, tilting, etc., is about 300 pounds per square inch. The open hearth department contains twelve 10-ton furnaces in a straight line, having a casting pit extending the full length, the ladles being carried on trucks extending across the pit, and running on rails laid on either side. The molds and ingots in this department are handled by traveling steam jib cranes, which seem to answer the requirements very well. Ingots for rails are bloomed down on a reversing mill in 10 passes to an 8-inch bloom, which is transferred on a buggy to a three high rail mill, and finished in 11 more passes. The capacity of this mill is about 200 tons per day, all the work of drawing and charging the furnaces, transferring and manipulating being done by hand. Labor-saving appliances are but little used in any of the Russian mills, especially in St. Petersburg, as labor is cheap in spite of the high tariff on everything—common labor being paid about 40 cents a day and skilled labor from \$1 to \$1.50.

The finished product of both the rail and structural mills looked first class, in fact it must be good to pass the very rigid government inspection, while the steel castings which they were making to take the place of forgings in gun carriages and locomotive construction equaled anything of the kind I ever saw.

The plate mill department is rather old-fashioned, having been built 15 or 20 years ago; the widest plate they could roll would be about 80 inches, I should judge; and in this department, as elsewhere, the number of men employed appeared excessive for the amount of material turned out as compared with our modern mills.

In the locomotive shops a great deal of new machinery had been recently added, and the general equipment was fairly good, but too crowded. Overhead cranes, some operated by steam, some by ropes and some by electricity, handled the material in the smith, machine, hammer or erecting shop, as the case may be, and the flanging and riveting work on the locomotives turned out was first-class in every respect. The government inspection was not only rigid, but absurdly arbitrary in some respects, though any one who has had much to do with government work knows perfectly well that unreasonable requirements and arbitrary inspection is not confined by any means to Russia.

The compound type of locomotive seems to be coming into very general favor, there being several different arrangements in use, though the favorite type appeared to be with the high pressure on one side and low on the other.

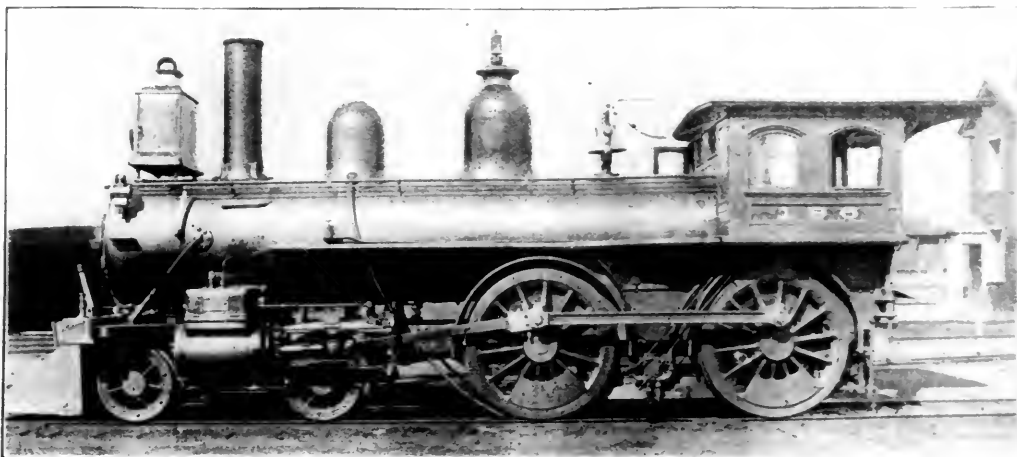
In the St. Petersburg mills, for the most part, the mill engines are of the non-automatic type, while as to boilers, I noticed in the Poutilof works, alone, boilers of the modified Babcock & Wilcox, the Lancashire, Cornish, horizontal tubular locomotive and plain cylinder type, many of these boilers being fired by the waste heat from heating furnaces.

At the "Nevski," another large works on the Neva, above St. Petersburg, there are two open-hearth furnaces of the acid type, as are all those at the Poutilof, and here also they build torpedo boats and locomotives. As illustrating the extreme rigidity of the government inspection I was informed that out of 200 plates submitted to the inspectors for the artillery department only 24 were accepted, the rest being rejected principally on tensile strength and ductility test. Sixty plates were ordered from the Belgian firm of Cockrill & Co., in order to complete their contract, and out of these 60, 48 were rejected.

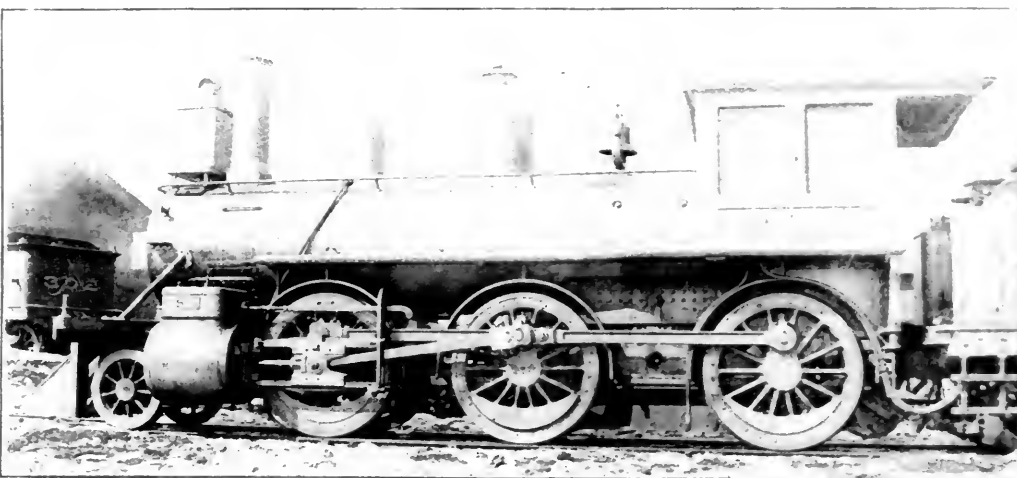
At the Alexandrovsky works, the principal output of which consists of plates and structural material, they have seven open-hearth furnaces, of which six are operated by the basic process. The metal is tapped directly from the furnace into the moulds, they being set on a revolving table in a small circular pit and brought alternately under a fixed funnel.

The object of this arrangement was, presumably, to save expense for pits, cranes and ladles. What the effect would be if the furnace broke out, as furnaces sometimes will, can be readily imagined by any one familiar with open-hearth practice. It is bad enough where you have a clear pit and good crane capacity without having a lot of mechanism in the pit, and cranes capable only of handling moulds and ingots to depend upon.

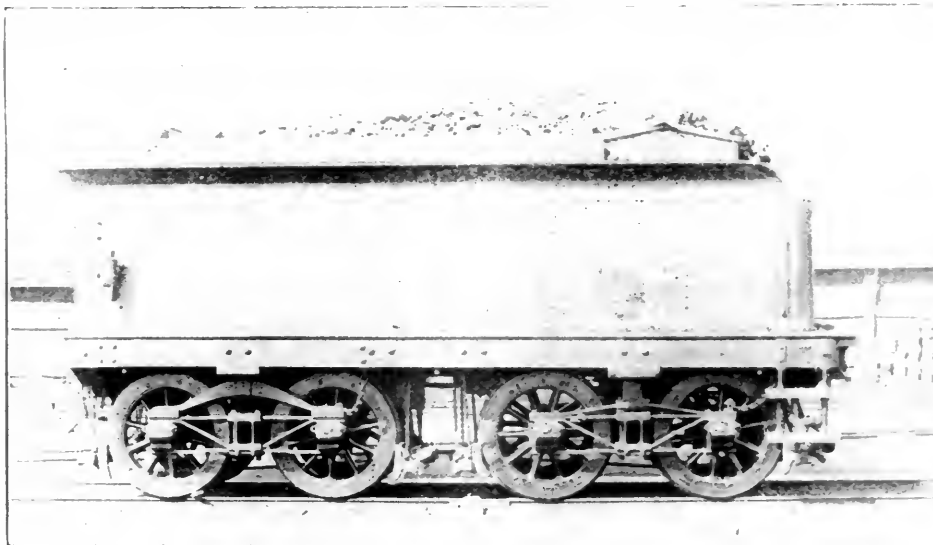
For rolling their plates they have a reversing mill operated by a three-cylinder engine, and all the plates are passed through straightening rolls as they come from the mill. The result is a very fine-looking plate of smooth surface and free from buckles. Very little handling is done here by mechanical means, as many as 17 men being



Light Passenger Locomotive for Local Service with 17-inch by 22-inch Cylinders.



Experimental Compound Locomotive of the Rhode Island System.
STANDARD LOCOMOTIVES OF THE GRAND TRUNK RAILWAY.



Standard Tenders Used on the Grand Trunk Railway.

required to draw a 5,000-lb. ingot from the heating furnace and take it to the rolls.

At Moscow, at the Gougon works, the arrangement of the open-hearth plants struck me much more favorably than did that of the St. Petersburg works, though, of course, the latter plants were older. At the Gougon works the furnaces, two in number, were of about 30 tons capacity each, with plenty of room both on the side of the charging floor and on the pit side, which was also properly equipped with hydraulic cranes. Crude petroleum from the Caspian Sea, brought up the Volga and Oka rivers in bulk in covered barges, is largely used for fuel at these works both for heating and boiler purposes, but it is not used in the open-hearth furnaces, nor did the method of using it seem the most economical. At the end of the furnace, and on the outside, the oil is allowed to fall in drops into a shallow iron trough, where it is ignited and is drawn by natural draft into the furnace. At these works, too,

they have recently put in some compound automatic engines built in England; have a good modern mill, and well-equipped nail, spike and wire factory. For this class of work they can compete successfully with other districts, but for heavy products they are handicapped on account of the high freights on all raw material. For fuel they are dependent upon coal and coke from England or Germany, or oil from the Caspian, a distance of some 1,500 miles, while much of their pig iron is either imported or comes from the Urals, a distance of a thousand miles.

As regards oil, too, all this distance is against the stream, and the Ural pig must come against the stream for at least half the distance, and I know from personal experience what pulling against the stream in the Volga means. During half the year, too, the rivers are not navigable on account of the ice.

Although there is an abundant supply of rich ore in the Ural Mountains, it is impossible to smelt it in large quanti-

ties there, owing to the absence of any fuel except charcoal; the government restrictions as to the quantity of timber felled in any district per annum, and other requirements as to smelting, rendering it difficult to produce iron in large quantities in this region, though the finest ores in Russia, and possibly equal to anything in the world, are found here. There is a fortune in it for any one who can devise a practical means of smelting Ural ore with crude petroleum, as the ore can be floated down to any point on the Volga to meet the oil from the Caspian.

Several schemes have been proposed, among others to soak coke in petroleum, and use the standard coke, which might possibly be of use if you could keep the oil from volatilizing long enough to be of any use in reducing the ore. Others claim to be able to reduce the ore by means of the oil, without the use of coke at all, but the schemes referred to me did not seem to hold out much hope of success.

The coming district in Russia for the manufacture of steel on a large scale is undoubtedly in the south, as that is the only district where coking coal is found in large quantities of a good grade; and here, too, there are some good hematite mines, notably at Krivoi-Rog.

The most successful plant in this neighborhood, and possibly in Russia, is the New Russia Iron Works, founded by a Mr. Hughes, an Englishman, in the early seventies, and recently converted into a joint stock company, with offices in London.

Situated on the Donetz coal field, they raise the coal right in their works yard, and have some hundreds of Coppee coke ovens, starting from the pit mouth and extending down to the blast furnaces, so that no unnecessary expense is incurred for re-handling.

Their blast furnaces are of modern design, are well equipped with hot blast stoves and independent blowing machines, and are capable of turning out about 200 tons of pig per day each.

At present all the steel for rails, which is their principal product, is made by the open-hearth acid process, but the metal is charged in a molten state from the blast furnaces. Their main reason for building an open hearth instead of a Bessemer plant was because at that time all the railroads in Russia were using iron rails, and they proposed to melt old rails and convert them into steel, which promised to be a remunerative business until, during the American boom of 1881, the price of iron rails rose to such a figure that the whole country was scouring for them, they being sold in large quantities, and imported steel rails put down in their place.

The Hughes Company are now, however, erecting a Bessemer plant and rail mill on modern lines, which will greatly increase their capacity and reduce the cost of manufacture.

At Sulina, on the extreme eastern edge of the Donetz coal field, and where the coal is a friable anthracite, the Postuchoff works are operating two blast furnaces with anthracite for fuel—the only two so operated in Russia—and the remainder of their plant is fired by the raw anthracite, or by gas prepared from the more friable and gaseous portions. At this point they obtain on the property on which the works stand limestone, building stone, silica sand, iron ore and coal, so that the location would seem to be an ideal one for a steel works, which would be the case if the iron ores were richer in iron and contained less phosphorus, and the coal were coking coal and contained less sulphur. They were about to erect two open-hearth furnaces here, one acid, one basic, using chrome ore from the Caucasus for lining the latter furnace.

In connection with this plant, where we were treated in the most hospitable manner—which, to be perfectly fair, was the case in connection with practically every works in Russia which we visited—the manager was anxious to have some particulars of the working of blast furnaces, on anthracite, in the United States, as regards the dimension, output, consumption of fuel per ton of pig produced, pressure of blast, etc.

Speaking generally of the steel and iron industry in Russia, it is more advanced than is generally supposed by outsiders, and though many of the mills are a little out of date, they were well up with the times when they were built, and with the recent revival of business there, and the encouragement given by the Government to open up new districts by the building of railroads, the manufacturers are taking advantage of the opportunity to remodel their plants on the most modern lines. The locomotive works of the Strauvee Company at Colomna are being equipped throughout with electric overhead cranes, hydraulic riveters, multiple drills, etc., and in the case of large tools, each one is driven by an independent motor. The Siemens-Halske Company have a large and successful plant in St. Petersburg, from which they ship motors and general electrical appliances all over Russia, and at the same time give object lessons, by the way in which their own shops are operated, as to the best and cheapest methods of running machine shops and similar establishments.

One of the oldest steel works in Russia is the Sormovo works at Nijni-Novgorod, where, besides making plates, tires and axles, and general merchant iron, they also manufacture a great many freight and passenger cars, and build compound engines for the vessels plying on the Volga. We traveled all night from Moscow to see these works, only to find them standing on account of its being a saint's day.

The town of Nijni-Novgorod is most widely known as the site of the great fair that takes place in August of each year, which it is said as many as 750,000 people annually visit either for trading or sight-seeing. But it is expected that the construction of the Siberian Railroad will soon reduce the importance of the fair, if not kill it altogether, as the necessity of its existence will cease as soon as communication with the people interested becomes rapid and regular.

Russia to-day offers a very inviting field for the establishment of manufacturing industries, especially in the direction of iron and steel, and more particularly as regards material required for railroads. The works visited by us were all running full time on orders showing good profits, and the government had some large contracts for rails, locomotives and armor plates to give out, some of which have since been placed. At present the building of railroads is hampered by the difficulty of obtaining rails and equipment, and with the present capacity of the mills and factories, it will take years to make up the existing deficiency, without counting the extensive districts in Russia itself, outside of Siberia, which are without railroad communication of any kind.

Rails were worth \$47 to \$51 per ton in St. Petersburg when we were there, or about \$40 at the mills in the south, there being a duty of \$20.50 per ton. Plates were worth about 4½ cents per pound, with a duty of \$29 per ton and tires 5½ cents per pound. The duty on light sheets amounts to \$34 per ton, and the selling price about 5 cents per pound.

As good pig iron can be produced in the South from \$17 to \$18 per ton, and rollers are paid from \$1.60 to \$1.70 per day in rail and structural mills, puddlers and sheet rollers, \$1 to \$1.20 per day; helpers from 45 to 50 cents per day, and common labor 35 to 40 cents per day, it will be seen that there is a very fair margin between cost and selling price, though from the number of men employed, and the difficulty of getting material good enough to pass the government tests, the returns are not as large as they appear on the surface. Still, with modern machinery and assured government contracts, which would be necessary, as the government is by far the largest buyer, Russia appears to offer one of the best fields in the world for investment to-day.

The great steam hammer, at the Bethlehem Company's works in Pennsylvania, is at this time the largest one ever made. It is single-acting, that is, the falling movement or blow is by gravity alone, steam being employed only to raise the "tip," as the British people call it. The falling weight is 125 tons, and the range 16.5 feet. The whole structure is 90 feet high from the floor, and the foundations extend 30 feet below, so the whole height is 120 feet. The piston rod is of steel, 16 inches in diameter. There are in use two other hammers of 100 tons, one at Creusot, and one at Rive de Gier, France; and one of 100 tons at Terni, in Italy. The next largest is 80 tons, at St. Chamond, France.

The largest double-acting hammer is at Aboukoff, in Russia, rated at 50 tons, but this rating will not do to compare with gravity hammers. The blows may equal in force 100 tons falling only. The great hammer at Bethlehem is outdone by a hydraulic forging press recently erected there that exerts a pressure of 14,000 tons. The force is not accumulated, but is direct by steam pistons acting on the water with a force estimated as equal to 16,000 horse power.

If the effect produced by these vast engines could be accomplished irrespective of speed or velocity there would be no need of such great weight, but an element of time enters into these forging processes, necessary because of inertia in large masses to be reduced, and also because

which, as all know, must have weight in proportion to the object struck, independent of the dynamic energy of the blows. Pile driving is another illustration. A light ram splinters the piles without moving them.—*Industries.*

The Standard Locomotives of the Grand Trunk Railway.

The officials in charge of the mechanical departments of the Grand Trunk Railway have taken great pains to standardize all parts of their rolling stock, so that the expenses for repairs have been lowered and the necessity of carrying a multiplicity of parts avoided. Their standard box car was illustrated and described in the *American Engineer* in 1895, and we now present a series of illustrations of the standard locomotives that are used, including all with the exception of the switching engine.

The class of which No. 83 is a representative is used on express service where the trains are comparatively light. The cylinders have a diameter of 18 inches, with a piston stroke of 24 inches and drivers 6 feet 1½ inches in diameter. It will be noticed that the tires on the drivers of this engine are held by Mansell retaining rings, that the connection for the driver brake is outside the wheels, and that while the portion of the engine above the running board shows the touch of the English influence in the smoothness and simplicity of the outlines, the mechanism is typical of American practice.

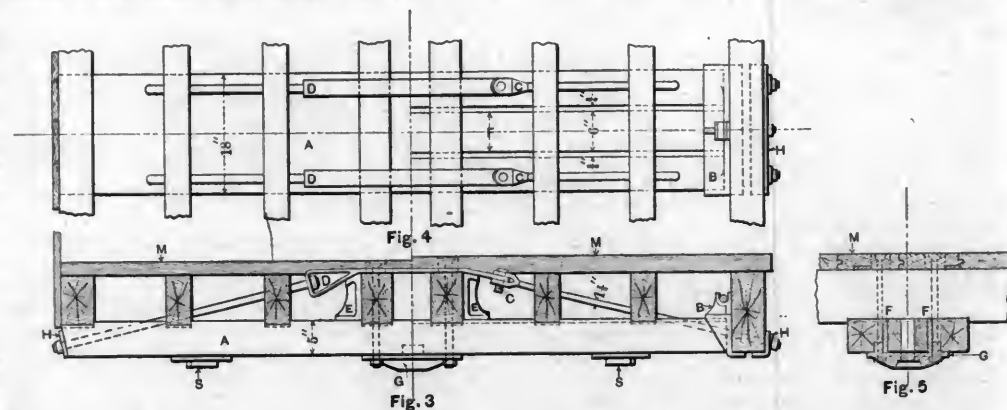
No. 93 belongs to a heavier class. Its cylinders are 18 inches diameter, with 26-inch stroke, and has drivers 6 feet 6 inches in diameter, which are of wrought iron, with tires held by the Beattie clip and tire bolts. It is used on the heaviest and fastest express service of the road, and, besides its weight and the dimensions of cylinders and driving wheels, is very similar to No. 83.

No. 572 represents the standard freight locomotive. Its cylinders have a diameter of 18 inches and a stroke of 26 inches, with a driver diameter of 5 feet 2 inches.

In No. 39 we find a double ended locomotive used in suburban passenger service, for, though Montreal is a comparatively small city, there is quite a heavy suburban traffic especially during the summer months. These locomotives haul five cars and are capable of picking up to speed with great rapidity. The cylinders are 17 inches by 23 inches, with 5 feet 2 inch drivers. The engine is practically an ordinary eight-wheeled locomotive with a trailing truck having two wheels. Engines similar to this have been in use on the Long Island Railroad for a number of years. This latter road had a number of light eight-wheeled passenger engines that were not heavy enough for regular service, so the tender was dispensed with, tanks placed along the running board, and a small coal space provided at the back. These Grand Trunk locomotives are similar, except that they were especially designed for the service in which they are working and have the advantages of ample coal and water space.

Finally we have the light passenger locomotive as illustrated by No. 196. The cylinders are 17 inches in diameter with a piston stroke of 23 inches, and drivers 5 feet 2 inches in diameter. The engine is used on local and accommodation trains.

On all of these engines it will be noticed that there is a great similarity in the design of all of the working parts, and that there is one feature that is very rare on this side of the border line. We refer to the jacketing of the firebox. The usual custom prevalent here of leaving the firebox to the tender mercy of all the breezes of heaven is a necessity for that portion of the firebox between the top rail of the frame and the running board, where it is occupied by the reach rod and the equalizer; but between the



some time must be allowed for the heated metal to flow when under pressure. This is more nearly attained by a heavy weight falling slowly.

The increase of hammers to the enormous proportions named is to acquire this time required, the principle culminating in the forging presses, more commonly employed all over the world for heavy work, especially in England, where hydraulic apparatus has attained the greatest development. The presses acting slowly permits the metal to move uniformly throughout, or "to the center," as it is called, while a quick blow acts only on the surface.

A familiar example of this is in the use of hand hammers

rails there is nothing to interfere with the jacketing, so our Canadian brethren, believing that a half loaf is better than no bread, have filled this space with a protective jacketing.

The compound locomotive illustrated is the only one that is owned by the road, and so has not arisen to the dignity of a class. Elaborate experiments are being conducted in order to determine its efficiency both in passenger and freight service. It has the Rhode Island type of intercepting valve. The cylinders are 19 inches and 29 inches in diameter, with a piston stroke of 26 inches, and drivers 5 feet 2 inches in diameter.

The truss rods of wooden body bolsters are usually made in three pieces, which facilitate their application and removal. The two end pieces are from 1 inch to 1½ inches in diameter and have large cast or wrought iron washers, *HH*, under the nuts on the outer end, the plane of contact

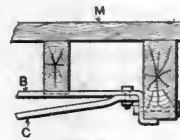


Fig. 8

Sometimes the two members of the body-bolster are welded together at the ends, but this is not an advisable

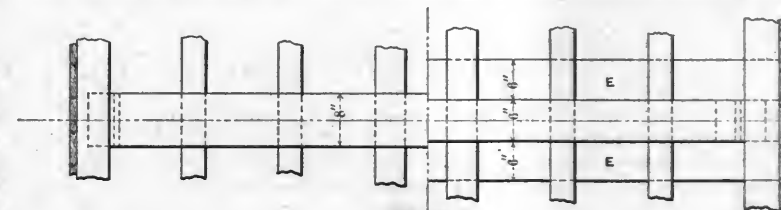


Fig. 10

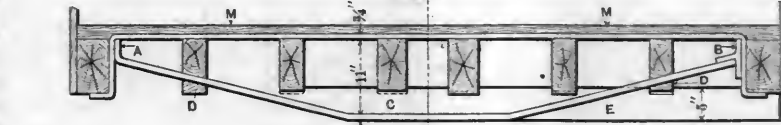


Fig. 9

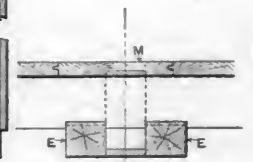


Fig. 11

As mentioned above, the distance between the two members of an iron bar-bolster is limited and usually does not exceed six inches. If more of an arch is desired, or when, on account of an unusually low floor or high truck, sufficient space between the latter parts cannot be obtained for a proper depth of bolster, the tension member can be placed on top of the floor timbers, as shown in Figs. 8 and 9, carried down on the inside of the sills, and under them. The compression member, which is placed below the sills,

This style of bolster can be used advantageously in cases

where the draw-bar attachments are fastened directly to the center sills of the car.

A combination of the wooden and iron body bolsters, is used on some roads, an iron-bar bolster, 6 inches wide, with the tension member on top of the sills is reinforced on each side by a piece of timber, *EE*, 5 inches deep and 6 inches wide, making a bolster 18 inches wide, the bottoms of the iron and wood being in one plane at the center; castings which lap over on to the wood parts are placed between the center and inside intermediate sills and the compression member of the iron part. Figs. 9 and 10 shows the general arrangement of this combination bolster to the right of the center line; it is shown in cross-section in Fig. 11. In addition to the body bolsters described, a number of others have been designed in which iron or steel channel bars or *I*-beams are used, but as comparatively few of these are in existence, and these principally on special kinds of cars, they will not be described here in detail.

Center Plates.

Center plates are usually made of cast iron, although pressed steel is coming into use to some extent. Those of cast iron are limited to one or two styles, the more common being that shown at *JJ*, Figs. 6 and 7, which consists of a ring of rectangular section cast to a flat plate, this ring fitting loosely into a similar ring on the truck center plate. The size of the section, as well as the diameter of these rings vary greatly, but four inches for the inside

Side Bearings.

The weight of the body of a car is carried entirely by the center plates when the car is on a straight and level track, and the weights of the body and load are evenly distributed each side of the center line; these conditions however, do not always prevail, and the center of gravity will not be directly over the center of the truck. As the center plates are comparatively small, other supports must therefore be provided to meet these conditions and to prevent undue and often dangerous oscillations when passing around curves at a high speed. These supports are the side bearings, *SS*, which are placed near each end of the bolster and are fastened to it by two or three $\frac{3}{4}$ -inch bolts. They are usually made of cast iron, with lugs on the sides for the bolts and flanges on the ends fitting over the bolster, and in their most common form the surfaces of contact on both body and truck side bearings are sections of flat rings, about three or four inches wide, drawn from the center of the truck.

When the car body is balanced there should be a space of about $\frac{1}{4}$ inch between the body and truck side bearings, but this is sometimes difficult to maintain on account of shrinking and bending of timbers and loosening of fastenings, and many cars are found on which the side bearings are in contact, causing more or less friction when rounding curves. To overcome this bearings have been designed in which a roller is supposed to do away with the friction,

pin cannot be removed or replaced conveniently, especially when the car is loaded. The pin shall have a slot in its upper end, through which a flat key of wrought iron passes, which rests on the top of the body-bolster and can be removed easily to allow the pin to drop low enough to remove the truck. This key should be about $\frac{1}{2}$ by 2 inches in section, with a head on one end and the other end long enough to have a hole drilled in it to take a ring or cotter.

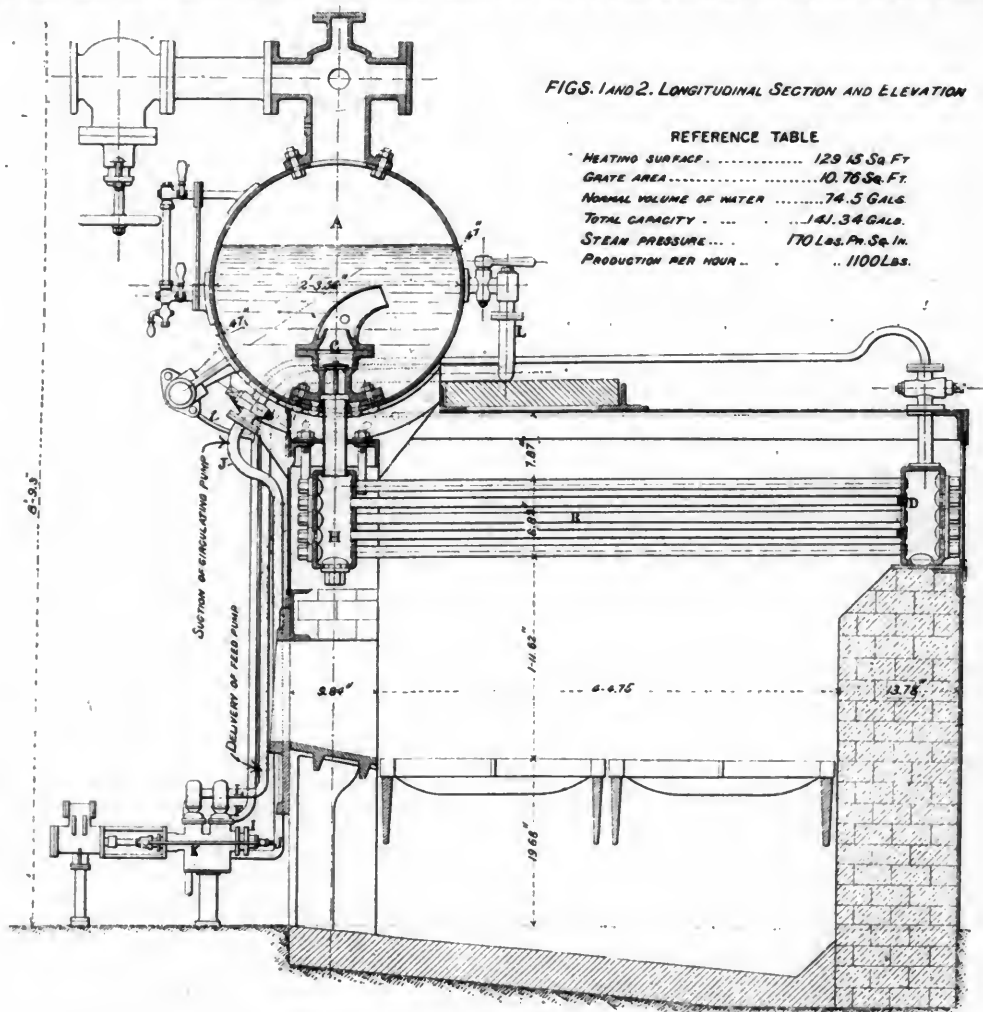
Both ends of the centre pin should be drawn down slightly tapering, to facilitate placing.

If a head is used on the centre pin it should not be made by upsetting the iron, but of a ring welded on, which can be broken or chipped off more readily in case the removal of the pin should be required in an emergency.

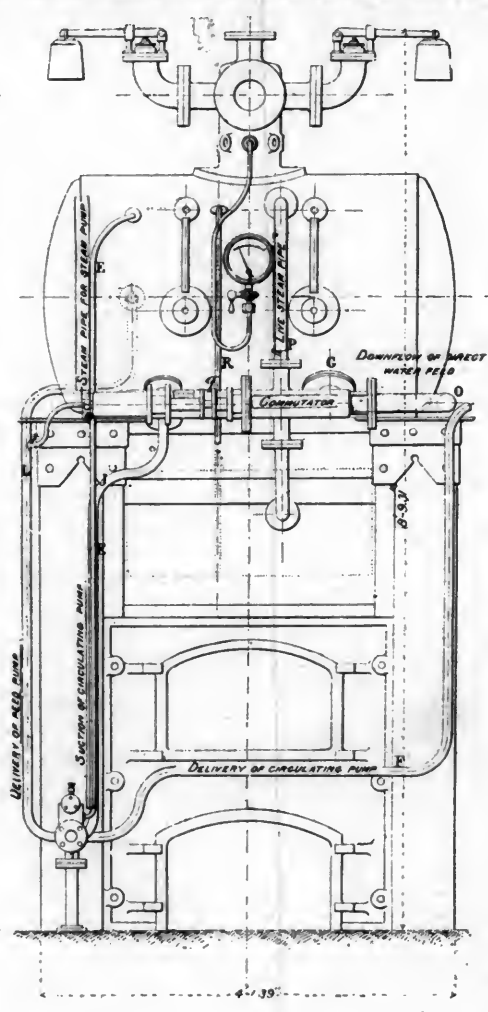
Floor.

The floor of freight cars, *MM*, is generally made of yellow or Norway pine and occasionally of oak. It is laid across the car, and is blind nailed securely to each sill. On box and other sheathed cars it extends to the inside of the sheathing, excepting in the doorway, where it is flush with the outside of the sheathing. On flat and gondola cars it is usual to have the floor extend about an inch beyond each side and end sill.

Floor boards are either tongued and grooved, or lapped, and vary in width from 6 to 10 inches. The thickness varies from $\frac{1}{4}$ to 2 inches on cars on which the floor is subjected to only ordinary wear, such as box and other merchandise



The Solignac Mixed Boiler.



diameter of the smaller ring is about the minimum, while the largest diameter is usually less than 12 inches, the section of the ring ranging from 1 to 2 inches each way. Some builders use two concentric rings on both top and bottom center plates, and their section is then about one inch square. This is shown at *GG*, Figs. 3 and 5. The other style of center plate consists of a section of a sphere on the body plate, resting in a section of a hollow sphere of the same diameter, which is about 10 inches on the truck center plate. At the center there is usually a small rectangular ring on the truck center plate fitting in a corresponding recess in the upper one, which prevents displacement. The idea of the sphere is to allow a certain amount of adjustment between body and truck of the car. Center plates ordinarily have flanges or lips on the sides which fit over the bolster and relieve the bolts of some of the strain. On wooden bolsters, especially when they are very wide, the flanges are sometimes omitted, and lugs are placed on the flat side of the plate which is let into the wood. These lugs are often made cylindrical, about one inch in diameter, and of the same length, but it is found that they frequently break, and stronger ones of rectangular section, about $\frac{1}{4}$ inches square and 3 inches long should therefore be used.

The center plate should be fastened very securely to the bolster, and four bolts $\frac{3}{4}$ inch in diameter are found to be about right.

but they have not proven much of a success, as the roller would soon wear flat and become stationary.

Several designs of roller side bearings embodying the well-known idea of a number of small rollers fastened together in a movable frame, forming a so-called anti-friction bearing, have been put on the market, but none are used very extensively.

When a car bears hard on the side bearings all the shocks caused by imperfections of the track are transmitted to the body and the car rides hard. To prevent this, and at the same time have a close adjustment between body and truck, side bearings are in use on some cars, especially for live stock, in which the lower bearing is forced upward by means of special springs inclosed in a case.

Center Pin.

The center pin (*P*, Fig. 3,) is a bar of round wrought iron, generally from $\frac{1}{4}$ to 2 inches in diameter, which passes through the body and truck center plates and bolsters and holds these parts in their relative position in case the plates should become broken or the body of the car be raised high enough for the center plates to disengage themselves. The pin is also a guide when putting the body on the trucks and is usually put in place before the body is let down.

Center pins are sometimes made with heads resting either on top of the body-bolster or in cast-iron sockets let into the floor; this, however, is not a desirable plan, as the

cars, and from $\frac{1}{4}$ to 3 inches on cars on where heavy materials such as coal, ore, stone, etc., are carried.

(To be Continued.)

The Solignac Mixed Boiler.

This boiler, as it is now built, varies very widely from the original one as it was first put upon the market. Like all new inventions, it has been subjected to successive transformations, based upon the very legitimate desire of satisfying all of the practical requirements that may be made upon it, and of taking advantage of everything that experience may have suggested. In its present form, however, it seems to have reached this goal, so that it is deserving of a careful examination, as being among that class of generators in which the production of steam is very high. The inventor, M. Solignac, calls it a mixed boiler because it partakes, at the same time, of the characteristics of those boilers carrying a large volume of water and of those composed of elements intended for the instantaneous generation of steam.

These two conditions, each of which would seem to necessarily exclude the other, could only have been harmonized with the greatest difficulty by the ordinary means, and it has only been by boldly turning aside from the beaten pathways that M. Solignac has been able to attain the results that he has.

We know that the free production of steam in multitubular boilers is intimately connected with the rapid renewal or circulation of water in the tubes; then, as it is a poor

(Established 1832.)

AMERICAN ENGINEER CAR BUILDER AND RAILROAD JOURNAL

7TH YEAR.

6TH YEAR.

PUBLISHED MONTHLY

BY
R. M. VAN ARSDALE,

MORSE BUILDING.....NEW YORK.

M. N. FORNEY,
W. H. MARSHALL, } Editors.

F. H. CLARKE, Advertising Manager.

FEBRUARY, 1896.

Subscription.—\$2.00 a year for the United States and Canada;
\$2.50 a year for Foreign Countries embraced in the Universal
Postal Union.

EDITORIAL ANNOUNCEMENTS.

Advertisements.—Nothing will be inserted in this journal for pay, EXCEPT IN THE ADVERTISING PAGES. The reading pages will contain only such matter as we consider of interest to our readers.

Special Notice.—As the AMERICAN ENGINEER, CAR BUILDER AND RAILROAD JOURNAL is printed and ready for mailing on the last day of the month, correspondence, advertisements, etc., intended for insertion must be received not later than the 25th day of each month.

Contributions.—Articles relating to railway rolling stock construction and management and kindred topics, by those who are practically acquainted with these subjects, are specially desired. Also early notices of official changes, and additions of new equipment for the road or the shop, by purchase or construction.

To Subscribers.—The AMERICAN ENGINEER, CAR BUILDER AND RAILROAD JOURNAL is mailed regularly to every subscriber each month. Any subscriber who fails to receive his paper ought at once to notify the postmaster at the office of delivery, and in case the paper is not then obtained this office should be notified, so that the missing paper may be supplied. When a subscriber changes his address he ought to notify this office at once, so that the paper may be sent to the proper destination.

At the annual convention of the Master Car Builders' Association held last June, a resolution was adopted, to the effect that the different railroad clubs be requested to each appoint a committee of three representative members of the association, the joint committee so appointed, to take into consideration the general remodeling of the M. C. B. rules of interchange. That committee has just published its report, which has been sent to members of the association and will doubtless call out a great deal of discussion. The committee has gone into the subject very fully, especially into the defects of standard couplers, and their report makes a pamphlet of 26 pages. Thus gradually, year by year, a system of law for the operation of railroads is being evolved and it seems probable that there will be a mechanical Blackstone, and a Kent's commentaries on cars, before very long.

New York City is to have an electrical exhibition, commencing on May 4 next and continuing until June 1. The exhibition is to be held under the auspices of the National Electric Light Association in connection with its nineteenth convention, and promises to be the largest and most interesting display of electrical apparatus of all kinds ever made in this country. The exhibition will be held in the great Industrial Building, which occupies the entire block on Lexington avenue between Forty-third and Forty-fourth streets. Many novel and unique features in electrical displays will be introduced in connection with the exhibition. There will be given a series of popular and practical lectures on electrical subjects by eminent scientists, also afternoon and evening concerts by famous military bands, and special spectacular effects, all of which will be open to the general public. Mr. Clarence E. Stump has been appointed General Manager of the exhibition.

London Truth says that the following notice is stuck up in all the tramway cars of Belfast, Ireland:

The habit of spitting in a public conveyance is a filthy one, and renders the person so offending subject to the disgust and loathing of his fellow-passengers.

Commenting on this the New York Evening Post says: "Now, why cannot the Manhattan Elevated and the Metropolitan Traction Companies stick up something of the same sort in large type in their cars? It would offend no one and it would probably stop the spitting of large numbers who have never before heard any objection to it."

We say amen to the Post's suggestion and will go still farther and recommend that such a notice should be conspicuously posted in every station and railroad car for the conveyance of passengers in the country. Colonel Hain

is disposed to be a reformer and a public benefactor. He could earn the everlasting gratitude of all the ladies who travel on his road, if he would adopt the Post's proposal and thus lessen the unspeakably nauseous, execrable, offensive, odious, loathsome, horrible, hateful, detestable, foul, unwholesome, beastly, and infectious practice of expectorating in public places. "We" are not a woman nor the husband of one, and therefore can perhaps only faintly realize the disgust to which they must be subjected by having their skirts soiled from the pollution of public conveyances by those who convert them into swineries. Perhaps we ought to apologize to the pigs for the latter comparison, as we never heard of a hog spitting, excepting one of the human kind.

Since the above was written the "pathologist" of the Board of Health of New York presented to that body a report on the spitting habit and its danger to public health. In this report it is said:

"We desire to direct your attention anew to the continual transmission of infectious disease in public places, through the expectoration of persons suffering with different forms of infectious diseases of the throat and lungs."

The adoption of the following among other resolutions is recommended:

WHEREAS, spitting in public places constitutes a public nuisance; therefore be it

Resolved, That notices be posted in all public places and in all surface and elevated cars in this city, signed by the Board of Health, warning passengers against expectoration upon the floors of these conveyances; and, further, that similar notices be posted in the stations of the elevated roads, warning against expectoration upon the platforms and stairs or on the floors of the stations.

Resolved, That similar notices be posted in the halls and assembly rooms of all municipal and federal buildings in the city.

Resolved, That the municipal authorities be requested to provide sufficient and proper receptacles for expectoration for such public places as are in their control, and that the managers of the elevated roads be required to provide similar receptacles sufficient in number for their stations and platforms, and that in all cases these receptacles shall be kept in a cleanly condition.

Resolved, That the officers of the Manhattan Elevated Road be requested to give peremptory orders to their guards to refrain from and to prevent, as far as is possible, expectoration from the trains into the streets, and to secure the enforcement of these orders.

The editor of this paper regrets that the practice of chewing gum was not included in the animadversions of our friend the pathologist.

LARGE LOCOMOTIVE GRATES VERSUS SMALL ONES.

At the October meeting of the Western Railroad Club a paper, by Mr. J. Snowden Bell, on Wide Firebox Locomotive Boilers, was read and was afterward discussed at the November meeting. The paper was largely historical in its character, and described the different forms of wide fireboxes which have been introduced during the past 50 years. Considering the fact that various forms of large fireboxes have been in use for so long a time it is somewhat remarkable that such elementary propositions as the relative merits of large and small grates should still be the main topic of discussion, when this subject is brought before an up-to-date association like the Western Railroad Club. In fact the discussion was by no means conclusive with reference to the primary question whether a large locomotive grate and firebox is better than a small one. In fact this debate reminds one of a boy's composition on the seasons, in which he said that "some loves Spring, some loves Summer, others Autumn and others Winter; but as for me give me Liberty or give me Death." That is, the participants in the discussion seemed to desire most to maintain a non-committal attitude: with reference to the question under consideration, so as to be free to use big or little fireboxes as they might choose. Now, in this as in a great many other instances in life, we must be governed by the necessities and not the utilities which control the problem. In locomotive practice a prime necessity which transcends all others—excepting perhaps that of safety to life and limb—is that a locomotive should generate enough steam to meet the maximum demands of its service. That is it must make steam enough to be able to pull the train, or make time, up the ruling grade in good and bad weather. Nearly or quite everything else must be sacrificed to this necessity. Economy is almost entirely subordinate to it. As a corollary to this the inference may be drawn that grates should be big enough to burn as much coal as is required to meet the demand of steam at such critical times. If the grate is smaller than this it will limit or reduce the capacity of the locomotive, and to do so will be more costly than to waste coal. In other words, the minimum size of the grate is limited by the maximum capacity of the engine.

On the other hand, more than forty years ago D. K. Clark, in his treatise on Railway Machinery, enunciated the principle that "the larger the grate the smaller is the economical consumption, even with the same heating surface, showing that the economic value of heating surface is reduced by increasing the grate." From this he drew the inference that "there may be too much grate-area for economical evaporation, but there cannot be too little, so long as the required rate of combustion does not exceed the limits to be afterward defined." Again, as though to emphasize this principle, he says: "The maximum economical hourly consumption increases directly as the grate-

area is reduced, even with the same heating surface; showing that the economic value of heating surface is increased by reducing the grate," and that by this simple expedient, the same heating surface can economically evaporate larger quantities of water per hour." Again the same author says: "As the economic value of heating surface depends so much on the grate-area, being less as the area is greater, the grate should be kept as small as is consistent with the demands for steam," and the practicable rate of combustion." A discussion by the Western Railroad Club—or better still by the Master Mechanics' Association—of these principles, enunciated by Clark so long ago, would now be very interesting. Are they true or is there any doubt about them? If there is it would be of the utmost importance to railroad companies that the true principle with reference to the proportions of locomotive grates and fireboxes should be ascertained, which could be readily done through a series of not expensive experiments if made by an intelligent person. Unfortunately most of our railroad managers seem to be wedded, or at least in love, with ignorance. They are always ready to spend any amount of money in contention or litigation, to protect themselves and advance their interests, but if it could be known, it is believed that the amount of money which is expended annually for the advancement of knowledge is very small.

In the discussion of the paper Mr. Barnes asserted somewhat confidently that "the experiments made on ocean steamers show so conclusively that a high rate of combustion is accompanied by loss in efficiency, that it does not seem that any one conversant with the facts could dispute the value of a large grate." Again, he said, "We have a great many experiments on locomotives in this country which show conclusively that locomotive boilers with large grates are more efficient than those with small grates, when boilers of equal shell diameter are doing the same work." This statement is just the reverse of Clark's conclusions. Which is right? Continuing the discussion, Mr. Barnes said: "A strong draft reduces the efficiency when a boiler is so much forced as locomotive boilers are. In stationary boilers, when the draft is very light, an increase of the draft sometimes brings greater efficiency; but when the draft is increased to anything like locomotive draft a farther increase brings less." He said further that what he "wished to emphasize is that, when fuel used per square foot of grate per hour is more than 150 pounds, the use of a larger grate will give a substantial saving." This leads to the query, "What is the most economical rate of combustion?" The maximum now is about 200. When that rate is attained the mean would probably be about 100. If now we could ascertain the most economical rate, would it be best to adopt it as a maximum, or an average rate of combustion? It may be that while a rate of 200 pounds per square foot per hour is wasteful, when the engine is working at its maximum capacity, that a grate proportioned for that rate working under such conditions would give the most economical average results.

Mr. Barnes could do no better service than to collate the experiments bearing upon this question and then analyze them and indicate their significance. Probably his confidence in the soundness of the propositions he enunciated would be a little shaken if all the evidence was collected and carefully weighed. It may be remarked incidentally that the interesting experiments which were made by John E. Martin in Chili, a report of which is published in the Proceedings of the Master Mechanics' Association for 1878, sustains Clark's views. Away back in the fifties Ross Winans was building his Camel engines with what were then considered very long and wide fireboxes for the Baltimore & Ohio Railroad. Samuel J. Hayes was then Master of Machinery and designed some ten-wheeled engines with fireboxes as wide as he could get between the wheels and rise flat slab frames on their sides. The grates were not as long as Winans' and part of them were covered with dead-plates. In a test of fuel consumption Hayes' engines beat Winans', and the latter then resorted to the use of dead-plates and obtained better results. Afterward, when Hayes became the Superintendent of Machinery of the Illinois Central Railroad, he equipped nearly all the Rogers and other engines in that line with what were called hopper grates; that is, there were inclined dead-plates in the sides and in the back, and the drop-door in front was also dead. These grates produced very good results with the inferior Illinois coal. When Mr. Wooten first tried one of his fireboxes for burning bituminous coal he left the whole immense grate open, but soon discovered that he could produce better results by covering part of it with firebrick.

There seems to be a good deal of evidence to sustain the principle enunciated by Clark, that the smaller the grate, provided enough coal can be burned in it, the greater the economy. Of course a rate of consumption of coal may be reached, with a powerful blast, at which much of the fuel is not burned but is lifted mechanically from the fire carried through the tubes and up the chimney. That such a rate is not economical need hardly be proved, but such a maximum rate of consumption may be required in order to have the most economical average rate when the locomotive is not working the hardest.

Investigation and experiment would probably show that some given rate of combustion per square foot of grate per hour is the most economical, or possibly that different rates are desirable according to whether the locomotive is

The Itelles are yours.

working hard or not. From this the inference may be drawn, that the open grate should be larger when the engine is doing its maximum work, than it is during an average or minimum exertion of power. In other words to produce the best results the area of open grate should be variable, to meet the requirements of the work to be done.

But in the consideration of the size of fireboxes and grates the fact is often lost sight of that there are really two questions involved, one concerning the area of the grate, and the other that of the volume or contents of the firebox, and that a large firebox may be used with a small grate, and if it can be shown, as Clark enunciated, that small grates are more economical than large ones, it does not follow that the fireboxes should also be small. A big firebox in combination with a small grate may be, and probably is more economical than a small firebox would be. There can be no doubt that the process of combustion occupies an appreciable amount of time, and it is also true that, with a powerful blast and a small firebox, that the movement of the air and gases in the firebox and tubes is very rapid. Probably when an ordinary locomotive is working hard not less than 250 cubic feet of air and gas is exhausted from the firebox in a second. As the cubical content of an ordinary locomotive furnace is only about half that volume, the air and gases in it must be changed twice during each second, so that whatever combustion occurs, must take place in half a second. If the size or volume of the firebox was doubled the air and gases would remain in it twice as long, and, conversely, there would be twice as much time for combustion to take place. It seems evident that under these conditions, better combustion would result than can be secured when less time is given for it to take place. The inference may then be drawn that the larger the firebox the more likely we are to secure good combustion, and if D. K. Clark is right about grates we must come to the apparently contradictory conclusion that the smaller the grate and the larger the firebox the better will the combustion be.

But there is another principle involved. Frederick Siemens long ago pointed out that as soon as flame comes in contact with any solid substance combustion is at once retarded, and it begins to smoke. This may be shown by holding a metal or glass rod in the flame of an ordinary gaslight. Siemens' inference from this was, that in all kinds of furnaces we should aim to keep the flame away from the sides and top as long as possible, or until the process of combustion is completed. This principle has been observed in the construction of ordinary egg-shaped stoves for burning bituminous coal and in foundry cupolas and blast furnaces, in all of which there is a small grate at the bottom and the sides then swell out above so as to be away from the flame as it rises from the fuel. Owing to the construction of ordinary locomotive fireboxes, and the limits to which they are confined, this principle could not be adopted and the sides are so placed—especially in those which are very narrow—that the flame comes in direct contact with the plates, which have water on the opposite side of them. By the use of wide fireboxes and contracted grates, the contact of the flame would not be so immediate nor direct as it necessarily must be with a narrow furnace. The ideal form for a firebox would be a hollow sphere, a form which has the least area of enclosing surfaces, in proportion to the internal space of any other. A sphere, however, would not be a convenient form for a firebox. If it is to be rectangular, a cube would have the least surface area of any other form, or in other words the nearer the width, length and height are to being alike the better.

If the preceding reasoning is sound, we will have the conclusion that the smaller the area of the open grate of a locomotive, provided enough coal can be burned on it, the greater the economy, and the larger and more nearly alike all the dimensions—that is its length, breadth and height—of a firebox are the better. Now these propositions are of very great importance to railroad companies. At present they are to a considerable extent merely tentative, and to be entirely convincing some experimental demonstration is required. It is believed that it would be immensely profitable to railroad companies if the required experimental investigation was made by some competent person to prove the soundness of these conclusions. Who will undertake to have it done?

Trade Catalogues.

[In 1894 the Master Car-Builders' Association, for convenience in the filing and preservation of pamphlets, catalogues, specifications, etc., adopted a number of standard sizes. These are given here in order that the size of the publications of this kind, which are not listed under this head, may be compared with the standards, and it may be known whether they conform thereto. It seems very desirable that all trade catalogues published should conform to the standard sizes adopted by the Master Car-Builders' Association, and therefore in soliciting catalogues hereafter it will be stated in brackets whether they are or are not of one of the standard sizes.]

STANDARDS.

For postal-card circulars..... 3½ inches by 6¼ inches.
Pamphlets and trade catalogues 6 inches by 9 inches.
Specifications and letter-paper..... 8½ inches by 12 inches.
COMPUTERS PUBLISHED BY COX COMPUTER COMPANY, 173 Greenwich street, New York.

This is a circular describing several kinds of "computers" which consist of circular card discs arranged to revolve in a foundation plate and with printed scales corresponding to the various factors of the formula. In the circular before us computers for pulleys and gearing, belting and

shafting are described. The company makes some 30 others for various purposes which they propose to furnish for advertising and other purposes.

A THIRD OF A CENTURY OF PROGRESS. Being a Brief History of the Development of the B. F. Sturtevant Company, Boston, Mass., 36 pages, 5 by 6¼ inches. (Not standard size.)

The title of this little publication describes its character accurately. It is a brief history of the company, illustrated first by a portrait of Mr. Sturtevant, the founder of the company, and further on with one of Mr. Foss, the present General Manager. Several views of the works as they appeared at different periods are also given, some of them made from excellent wash drawings. There are also scattered through the "history" small engravings representing various machines made by the company, but which are hardly worthy of very high commendation. The little volume gives, however, an excellent idea of the wonderful progress of the establishment, which was started by a young shoemaker within the recollection of many of us who are no longer young. The pamphlet is admirably printed on excellent paper.

THE NEWTON MACHINE TOOL WORKS, of Philadelphia, announce that they have removed to their new works at Twenty-fourth and Vine streets, and send a circular giving internal and external views of their new works and small illustrations showing the various kinds of machinists' tools which they manufacture.

THE NATIONAL MALLEABLE CASTINGS COMPANY, OF CLEVELAND, O. 113 pages, 9 by 12 inches. Standard size.

This latest catalogue of the company serves as a striking object lesson of the extent to which malleable iron is applied in car construction. The whole 113 pages are filled with well executed half-tone engravings in vignette illustrating the various articles for which the company has patterns. Each article is given a number and beneath it is printed a short description giving dimensions, etc., that may be of value to the purchaser. The last pages are occupied by a very complete index, so that any article can be easily found. The book is printed on heavy calendered paper, and is an example of fine presswork. Among the special articles to which attention is called are the Tower coupler, the National car-door fastener, center plate, journal box and journal box lid, the Eubank car door and fixtures, and Coffin's carline and sill pockets. For the rest the work includes pretty much all the metal work of a car.

THE NEW BRITAIN MACHINE COMPANY. Manufacturers of Chain Saw Mortisers, Case Engines, etc. New Britain, Conn. 12 pages, 6 by 9 inches. (Standard size.)

Probably a good many readers will be disposed to ask what a "chain saw mortiser" is? In reply it may be said that it is a wood-working machine in which, as described in the catalogue before us.

"The cutting is performed by a steel chain, each link of which has a sharpened tooth so formed as to carry away its own chip, and is presented to the work a thousand times a minute. This will illustrate the possibilities of the machine for rapid work.

"This chain, driven by a sprocket, travels over, and is guided by a chain-bar having an anti-friction bearing at its lower end. The table holding the work is fed automatically up towards the chain, the mortise, either "blind" or "through," is made at a single cut and the table rapidly descends to the starting point ready for another mortise so quickly as to almost limit the machine's output by the ability of the operator to supply it with work. Under ordinary circumstances, from 400 to 500 four panel doors should be put through in ten hours (each door having ten accurate, clean mortises), and other work in proportion, depending on the size of mortise and hardness of stock."

The machine is illustrated with very good wood engravings and its advantages are fully set forth. The chain which does the mortising is shown by a separate engraving, in its relations to a mortise in a wooden beam.

The Case steam engine is also illustrated, which is a self-contained vertical engine. It would be much more satisfactory if a sectional view showing the internal construction of this engine was given. It is announced in a slip enclosed with the catalogue that Mr. Sidney B. Whiteside, of 139 Liberty street, New York, is the selling agent for this company.

CATALOGUE NO. 4. THE WEIR FROG COMPANY, MANUFACTURERS OF FROGS, SWITCHES AND CROSSINGS. Cincinnati, O. 278 pages, 4½ by 8½ inches. (Not standard size.)

This is another example of the many admirable catalogues which are now issued by our manufacturers of railroad material and appliances. The only faults which we can find with it is that it is not a standard size, and the other is that its usefulness would have been much increased if somewhat fuller elementary explanations had been given of the construction and appliances illustrated. That which is given is, however, so good that—like poor Oliver, in Dickens' immortal story—we are inclined to "ask for more."

The book opens with a sort of invocation to the "patrons" of the company, which is followed with "instructions for ordering material."

Frogs are the first structures which are illustrated, and described, the opening portion of this department being an explanation of the methods heretofore employed for constructing frog-points and that now adopted by this company. A large number of frogs for various purposes and

localities are then illustrated with excellent wax-process engravings showing plan and sectional views of the frogs. The second portion is devoted to crossings, which are similarly illustrated. This is followed by a chapter on switches, in which the various types are illustrated and described, and this is supplemented with descriptions of switch stands which are represented by some excellent wood engravings. Chairs, rail-braces bridge-guards, station signals, derailling switches, frogs and switches for light rails are all described and illustrated. Street railway track work has a separate department devoted to it, in which nearly all the appliances enumerated above, but which are adapted to that kind of service are shown and explained.

At the end of the book a series of admirable tables are given relating to track work. These include tables for the leads for turn outs, for crossovers, bills for crossties for turnouts, crossovers and crossings of various kinds, several giving the number of feet (board measure) in cross-ties, others in which the quantities of rails, angle-bars, spikes, fish-plates and bolts required per mile of track are given. There are also tables of middle ordinates in inches for curving rails, decimal parts of an inch and a foot for each sixty-fourth of an inch, and a list of the weight and size of rail sections carried in stock by the Weir Frog Company.

The book is printed on good wood-pulp paper, is well bound and of convenient size and form, and is altogether worthy of commendation excepting that it is not of standard size.

MORISON SUSPENSION FURNACES FOR STATIONARY BOILERS. Manufactured by the Continental Iron Works, Brooklyn, N. Y. 25 pages, 9 by 11 inches. (Not standard size.)

The chief purpose of this publication is to describe corrugated iron furnaces, and set forth their advantages. The book opens with an excellent perspective view, made from a wash drawing of the Continental Iron Works. There is then a very good dissertation on internal furnace tubular boilers, with references to some excellent line engravings, showing sectional and other views of a "Scotch," a "Locomotive," or "Gun Boat" boiler provided with the internal corrugated furnaces. The relative advantages of such boilers compared with those of the water-tube type are discussed, and the arguments in favor of the "suspension furnaces" are fully set forth.

Half tone perspective views are given of a boiler of 125 horse-power with a single furnace, in use at the Eighteenth street station of the Consolidated Gas Company, in New York, and another of a battery of five similar boilers now at the Milburn Pumping Station of the Brooklyn City Water Works. There is also a full sized sectional view showing the form of the corrugations, and tables giving the working pressure and thickness of the Morison furnaces, and another table showing the method of calculating the power rating of internal furnace boilers.

The Morison patent furnace door is also a specialty of manufacture by this company, and is illustrated and described at the end of the Continental Company's very neat catalogue, the cover of which may be especially commended for its very simple and pleasing design.

American Machinist.

In the first number of this year it is announced, in this widely-known journal, that the control of the paper has passed into the hands of Meers, Sinclair & Hill, the proprietors of *Locomotive Engineering*. The form and size of it has been changed, and those who have been familiar with the appearance of the old paper will be obliged to become acquainted with their former friend in a new dress. Whether the dignity of the old paper is to be maintained or the style which has been characteristic of *Locomotive Engineering*, and which appears to be popular, is to be adopted in both is not yet apparent.

Circular of Inquiry on Freight-Car Doors and Attachments.

The following circular has been issued by the committee of the Master Car Builders' Association:

Your committee, appointed to report on the latest improvements and best practice in freight-car doors and attachments, requests that you will co-operate by replying as promptly as possible to the questions given below:

1. Give your experience and the results obtained from the use of the different freight-car doors in use on your road.
2. What style of door do you prefer—the overhead hung, the bottom hung, or other style hung door, and why?
3. What style of door or doors are standard on your line, and what are their advantages over other doors?

Please furnish blue prints, sketch or full description of your standard door or doors, including end doors and attachments, covering the following detail:

- A. Size of doors and style of construction.
- B. Style of hangers used.
- C. Style and shape of rail and size of same.
- D. Method of securing rail to body of car.
- E. Locks and their attachments and method of application.
- F. Stops, both front and back.
- G. Brackets at bottom of door, including common brackets and special safety brackets, to prevent opening of door without breaking of seal.
- H. Wedges, shoes, etc., used on bottom of door.
- I. Description of any peculiar construction of bottom of door where it runs into brackets or on rail.
- J. Description and name of any patent device in use in connection with door hangings or fastenings, not brought out by preceding questions.

Please forward replies to F. H. Soule, General Car Inspector, N. Y. N. H. & H. R. R., New Haven, Conn., before February 20, 1896.

Personal.

Mr. Clarence F. Barker has been elected General Manager of the Cairo Short Line.

Mr. H. C. Landon has been appointed Chief Engineer of the Chicago, Peoria & St. Louis.

Mr. John D. Campbell has resigned as Master Mechanic of the Buffalo & Susquehanna Railroad.

Mr. Remsen Crawford, of Atlanta, Ga., has been appointed press agent for the Plant system.

Mr. J. C. Hennessey, Superintendent of the Missouri Pacific Terminals at Kansas City, has resigned.

Mr. W. C. Brown has been appointed General Manager of the Chicago, Burlington & Quincy Railroad.

Mr. H. A. Riggs, Chief Engineer of the Toledo, Ann Arbor & North Michigan Railroad, has resigned.

Mr. La Mott Ames, who has been Master Mechanic of the Beech Creek Railroad for a number of years, has resigned.

Mr. A. H. Thorpe has been appointed assistant to the General Manager and Purchasing Agent of the Ohio River Railroad.

Mr. F. C. Gates is acting as Purchasing Agent of the Wheeling & Lake Erie Railroad during the illness of Mr. F. S. Deal.

Mr. Samuel Irwin, Superintendent of the Car Department of the Missouri, Kansas & Texas Railroad, died Jan. 5, of apoplexy, at Sedalia, Mo.

Mr. John Warwick has been appointed Purchasing Agent of the railroads comprising the Seaboard Air Line, with headquarters at Portsmouth, Va.

Mr. A. H. McLeod, formerly General Freight Agent of the Cincinnati, Hamilton & Dayton Railroad, has been appointed Traffic Manager of that road.

Mr. Thomas Orchard, Master Car Builder in charge of the Carbondale, Pa., shops of the Delaware & Hudson Canal Co., died recently at the age of 76 years.

Mr. George W. Parker, President and General Manager of the St. Louis, Alton & Terre Haute Railroad, has resigned the latter office and retired from active service.

Mr. Seeley D. Dunn has been appointed Superintendent of the Owensboro & Nashville Division of the Louisville & Nashville Railroad, with headquarters at Russellville, Ky.

Mr. F. J. Cole, formerly Mechanical Engineer of the Baltimore & Ohio Railroad, has resigned and accepted the position of Chief Draughtsman with the Rogers Locomotive Company.

Mr. W. A. Garrett, Superintendent of the Terminal Association of St. Louis, has resigned in order to take the position of Superintendent of the Western division of the Wabash Railroad.

Mr. A. M. Tucker, formerly General Manager of the New York, Pennsylvania & Ohio Railroad and its leased line, has been appointed General Agent of the New Erie Railroad Company, with headquarters at Cleveland, O.

Mr. H. Delaney has been appointed Master Mechanic on the Philadelphia & Reading Railroad. His office will be Third and Berks streets, in Philadelphia, and he is to have charge of the Philadelphia and New York Division.

Mr. L. R. Pomeroy, who was recently of the firm of Coolbaugh & Pomeroy, announces that he has been appointed sales agent for the Cambria Iron Company and the Latrobe Steel Company, with an office at 33 Wall street, New York.

Mr. Carl W. McKinney, General Manager of the Lackawanna Iron and Steel Company, has resigned on account of ill health. He will be succeeded by Mr. Henry J. Wehman, the present General Superintendent and Chief Engineer of the company.

Mr. Andrew F. Burleigh has been made sole receiver for the Northern Pacific Railroad by Judge Gilbert, of the United States Court at Portland. Judge Gilbert said a change was necessary, not for any personal reason concerning present receivers, but for more harmonious management of the road.

Mr. William Duncan, Traffic Manager of the Baltimore & Ohio Southwestern, has resigned that position, to take effect on Feb. 1. Mr. Duncan has been in active railway service for nearly 30 years, and will retire from railway work, but will become President of the Ludlow & Saylor Wire Company, of St. Louis, Mo., a concern in which he is largely interested.

Mr. Stephen C. Mason, Assistant Statistician of the Interstate Commerce Commission, has resigned to accept a responsible position with the McConway & Torley Company, of Pittsburgh, Pa. Mr. Mason has been connected with the Commission over eight years, and for the last three years in direct charge of the statistical division and of the compilation of the statistical reports published by the Commission.

Mr. Thomas Prosser, Sr., for more than 40 years a member of the firm of Thomas Prosser & Son, the American representative of the Krupp works in Germany, died on Jan. 10, at his home in Brooklyn, after a long illness. It is nearly a year since he has been engaged in active work. He was born in Worcester, England, 67 years ago and came to this country with his parents when he was nine years old. His father was engaged in the steel business in Paterson, N. J. In 1851 the father organized the firm of Thomas Prosser & Son, and commenced business in Platt street, near Gold, New York. While at the International Exposition in London in 1853 he met Herr Krupp, the founder of the Krupp works, with whom he formed a lasting friendship. He became the American representative of this firm and the business relations thus established have continued uninterruptedly to the present time. Thomas Prosser & Son have dealt mainly with railroads, steamship companies and machinery manufacturers. It is expected that Mr. Thomas Prosser, who has been connected with the firm for a number of years, will succeed his father as the head of the house.

Mr. Alfred E. Beach, who has been one of the editors and proprietors of the *Scientific American* for nearly fifty years, died on Jan. 1, at the age of 70, at his home in New York. He was the son of Moses J. Beach, the founder of the *New York Sun*, but, with the exception of a short period passed in his father's office, his entire business life has been spent as a member of the firm of Munn & Co., the solicitors of patents, which he established in 1846 with A. D. Munn. His firm bought the *Scientific American* and Mr. Beach became its editor, having been responsible for this department during all of these years. Outside of his work in the firm as a patent solicitor and editor, he devoted a considerable portion of his time to the development of his own mechanical ideas, and the list of his inventions is an important one. As early as 1853 he exhibited a type writing machine at the Crystal Palace Exhibition in New York, for which he received a gold medal. It had practically all of the devices of the typewriting machines of to-day. He devised a pneumatic tube system for carrying the mails and a pneumatic railroad, of which an elevated experimental section was built. The Beach Pneumatic Transit Company, of which Mr. Beach was President, built a section of underground road beneath Broadway in 1869. This section was built without interfering with the street traffic by the Beach hydraulic shield, the parent of those used at the St. Clair tunnel, on the City & South London Underground Railroad, and elsewhere.

Queen Victoria's Cars.

The official *Railway Gazette* states that the two railway carriages which the queen uses on her continental journeys were built for Her Majesty in Belgium, and they are her own private property. They are kept, when not in use, at Brussels, at the Gare du Nord, and have just been thoroughly overhauled and renovated. They are always carefully covered up to preserve them from injury. The day saloon is furnished with two sofas, two armchairs, one large footstool, all covered with blue silk, with yellow fringe and tassels. The walls are hung with blue silk for the dado, and pearl gray above, brocaded in pale yellow with the rose, shamrock and thistle. The curtains are blue and white, and a dark Indian carpet covers the floor. There is a large center table and two small ones. The ventilator in the center of the ceiling is of cut glass, and there are four lights in the ceiling. The carriage is lighted at night by four oil lamps fixed in brackets on the walls while shaded reading lamps are also used. There are electric bells, and one of the Highland attendants travels in a separate small compartment in front of the saloon. A short covered corridor connects the day saloon with the sleeping carriage, which is divided into a suite of small rooms. The dressing room, which is hung in Japanese style, with bamboo on the floor, contains a white metal bath and a washstand covered with red morocco leather. All the toilet articles are of the same metal as the bath. The bedroom is decorated in gray and brown. There is a large bed for the queen and a smaller one for Princess Beatrice, both of which were manufactured in the royal stores at Windsor, and all the bedding is bought fresh for each journey, and taken away afterward. There is also a luggage room, in which the two maids sleep on sofas.

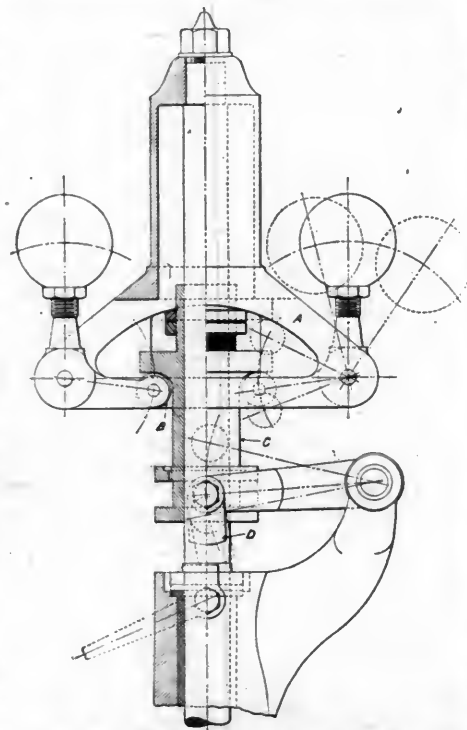
A High Speed Belt Governor for Corliss Engines.

The close adjustment to speed that engine builders have been compelled to guarantee for electrical work has brought about a marked improvement in the regulating apparatus of all engines both high and low speed. While the high speed engines have been brought to a very close regulation with comparative ease, the difficulties have been greater with the low, owing to the longer period required for the performance of a complete cycle. In order to obviate this last difficulty, the Lane & Bodley Company of Cincinnati, O., have adopted a high speed governor for the regulation of their Corliss type of engines. This governor is shown in some detail by the accompanying engraving of half elevation and section, and was used on the 22-inch by 48-inch engine that was exhibited by them at the Atlanta Exposition, and

whereon the regulation was so close that in the driving of the general electric monocylic generator there was never a variation of more than one volt in the generation of a current averaging 107 volts.

This governor is driven by the usual belt and bevel gearing connection, the balls being run at a speed of 196 revolutions per minute. They are carried on a frame A attached to the top of the spindle and are fastened at the end of a bell crank whose horizontal arm carries a roller B bearing on the underside of a shoulder on the sleeve C, which is thus raised as the balls are thrown outward by the centrifugal force due to their rotary motion, and against a spring tending to bring them to the extreme inner position, this spring not being shown in the engraving. The rising and falling of this sleeve regulates the point of cut-off in the usual way.

When the engine is stationary the weight of the sleeve and the pressure of the spring are sufficient to raise the balls and throw them into the inner position, as shown by the dotted lines, in which position steam is entirely cut off, and there would be no admission were the throttle to be



High-Speed Belt Governor for Corliss Engines.

opened. To facilitate starting, the sleeve is slightly raised and the stop D so set that it is blocked up and the starting bar used in the ordinary way. As the engine gathers speed the stop drops out and the sleeve is held in suspension by the action of the balls. But if the governor belt should, at any time, break, fly off, become loose or otherwise inoperative and the balls stop, the sleeve at once drops to the lowest position and cuts off all steam admission to the cylinder.

Thus the rapid motion of the balls enables a close adjustment to speed to be maintained, while any accident to the apparatus itself causes the steam to be shut off and all damage from racing prevented.

A statement that worm gearing, if used for power transmission in electrical works, should be employed only in conjunction with low-speed motors, has brought out a remark from Herr E. Kolben, of the Oerlikon Engineering Works in Germany, that high-speed motors should be adopted in such cases if the best results are to be obtained. He points out that a great prejudice against worm gearing has hitherto existed, on account of its having been regarded as an inefficient means of transmission. He believes that much depends upon the construction of the gearing and refers to tests recently carried out by Professor Stodola, of the Zurich Polytechnic, with the ordinary double-thread worm gear of the Oerlikon Engineering Works. The worm was 80 millimeters in diameter, had a multiple-ring bearing, and engaged with a worm wheel having 28 teeth, the wheel being of bronze, 373 millimeters in diameter. The whole of this gear was placed in oil in a cast-iron box. The gear was coupled to a 20 horse-power electric motor and the brake was applied on the worm wheel shaft. At 1,500 revolutions a useful performance of 21 horse-power was given on the brake, the efficiency amounting to 87 per cent. Herr Kolben is of the opinion that the efficiency with the motor fully loaded will increase even beyond 90 per cent, if the speed is high, the worm made of tool steel polished, the worm teeth of bronze, and the friction of the whole mechanism on the starting of motors at full load is reduced by having the pressure taken up by starting disks arranged on both ends of the worm.

He began the Professional Engineering Exam, had a wheel 100 millimeters in diameter, oil in a 100-hp power worm gear, and a 100-hp efficiency of 100%. In his opinion, the increase in worm gear size, and the starting of pressure of the

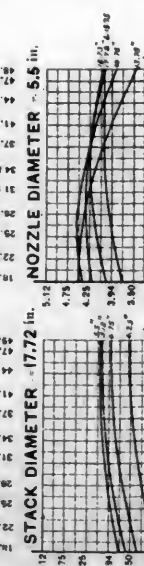
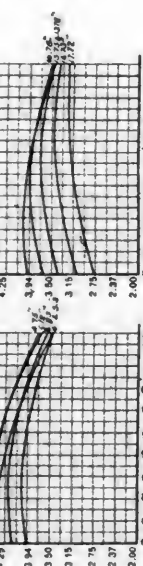
* Paper read before the German Society of Mechanical Engineers.

I. CYLINDRICAL STACKS

THE SAME STACK WITH 5 DIFFERENT BLAST NOZZLES

STACK DIAMETER - 17.72 in.

NOZZLE DIAMETER - 5.5 in.

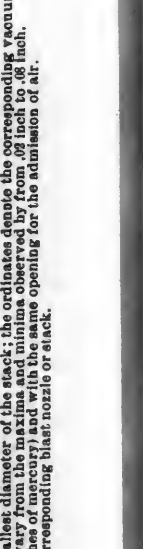
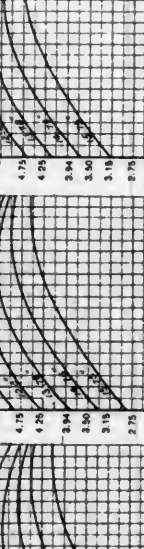
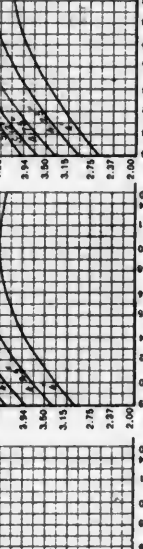
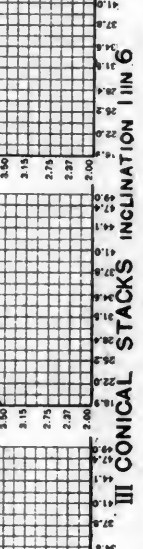
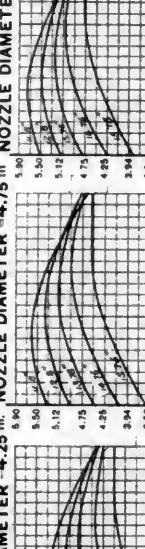
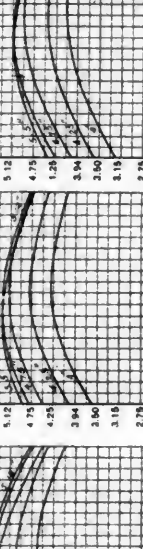


II. CONICAL STACKS INCLINATION 1 IN 12

THE SAME STACK WITH 5 DIFFERENT BLAST NOZZLES

STACK DIAMETER - 12.8 in.

NOZZLE DIAMETER - 5.12 in.



III. CONICAL STACKS INCLINATION 1 IN 6

THE SAME STACK WITH 5 DIFFERENT BLAST NOZZLES

STACK DIAMETER - 14.76 in.

NOZZLE DIAMETER - 5.12 in.

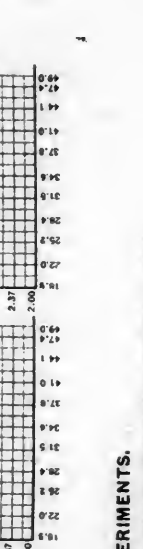
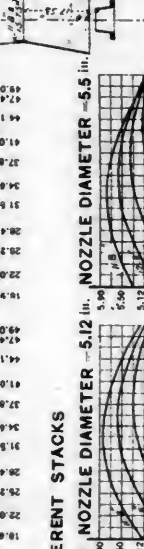
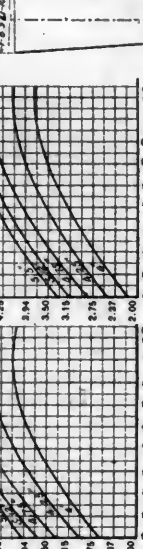
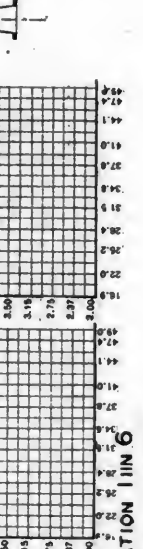
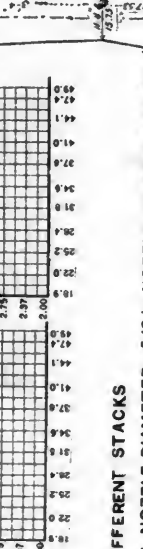
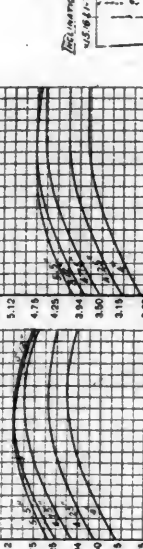


PLATE I.-DIAGRAMS OF RESULTS OBTAINED IN THE HANOVER SMOKESTACK EXPERIMENTS.

NOTE 1. The abscissas give the distance of the top of the blast nozzle below the smallest diameter of the stack; the ordinates denote the corresponding vacuum in inches of water.

2. The curves are plotted from an average of the values obtained, and they vary from the actual values by not more than 0.1 in. of vacuum.

3. All of the observations were made with the same steam pressure (3.94 inches of mercury) and with the same opening for the admission of air.

4. The figures at the right hand end of each curve are the diameters of the corresponding blast nozzle or stack.

GENERAL DIMENSIONS OF THE VARIOUS CLASSES OF LOCOMOTIVES ON THE GRAND TRUNK RAILWAY.

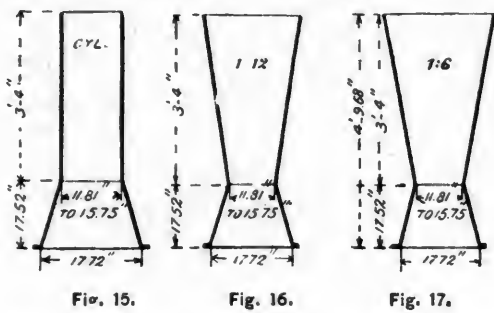
Class of engine.	No. 39 double ender with side and back tanks 17 in. x 22 in. x 5 ft. 2 in.	No. 82 express, 18 in. x 24 in. x 6 ft. 1 1/2 in.	No. 93 express, 18 in. x 26 in. x 6 ft. 6 in.	No. 196 light pas- senger, 17 in. x 22 in. x 5 ft. 2 in.	No. 326 compound motive ("H. I.") 29 in. x 26 in. x 5 ft. 2 in.	No. 573 simple mo- tor, 18 in. x 26 in. x 5 ft. 3 in.
Gage.	4 ft. 8 1/2 in.	4 ft. 8 1/2 in.	4 ft. 8 1/2 in.	4 ft. 8 1/2 in.	4 ft. 8 1/2 in.	4 ft. 8 1/2 in.
Kind of fuel used.	Bituminous.	Bituminous.	Bituminous.	Bituminous.	Bituminous.	Bituminous.
Weight on front truck, in working order.	35,112 lbs.	38,526 lbs.	33,908 lbs.	32,704 lbs.	21,840 lbs.	16,184 lbs.
Weight on back truck.	19,112	17,424	16,388	15,502	11,812	8,028
Total weight on driving wheels.	66,584	105,952	86,296	86,296	118,412	104,212
From center of front truck to center of main driving wheels.	10 ft. 8 in.	12 ft. 2 in.	12 ft. 2 in.	10 ft. 8 in.	15 ft. 2 in.	14 ft. 8 1/2 in.
From center of front truck to center of front driving wheels.	10 ft. 8 in.	12 ft. 2 in.	12 ft. 2 in.	10 ft. 8 in.	15 ft. 2 in.	14 ft. 8 1/2 in.
From center of front truck to center of main driving wheels.	10 ft. 8 in.	12 ft. 2 in.	12 ft. 2 in.	10 ft. 8 in.	15 ft. 2 in.	14 ft. 8 1/2 in.
From center of front truck to center of back driving wheels.	10 ft. 8 in.	12 ft. 2 in.	12 ft. 2 in.	10 ft. 8 in.	15 ft. 2 in.	14 ft. 8 1/2 in.
From center of front truck to center of back main driving wheels.	10 ft. 8 in.	12 ft. 2 in.	12 ft. 2 in.	10 ft. 8 in.	15 ft. 2 in.	14 ft. 8 1/2 in.
From center of front truck to center of back truck.	8 ft.	8 ft. 6 in.	8 ft. 6 in.	8 ft.	8 ft.	8 ft.
Rigid wheel base.	8 ft. 4 in.	8 ft. 6 in.	8 ft. 6 in.	8 ft.	8 ft.	8 ft.
Total wheel base of engine.	29' 3"	28' 11"	28' 11"	21 ft. 11 in.	23' 8"	23' 3 1/2"
Length of engine and tender over all.	No tender.	46' 11"	46' 11"	45' 2 1/2"	46' 7 1/4"	46' 7 1/4"
Length of main connecting rod, center to center.	39 ft. 7 1/2 in. on only	57' 11 1/4"	57' 11 1/4"	56' 2 1/4"	56' 7 3/4"	56' 7 3/4"
	8 ft. 10 in.	7' 10"	7' 10"	6' 10"	7' 3"	7' 3"

CYLINDERS, VALVES, ETC.						
Transverse distance from center to center of cylinders.	6 ft. 4 in.	6 ft. 4 in.	6 ft. 3 1/2 in.	6 ft. 4 in.	6 ft. 9 in.	6 ft. 9 in.
Diameter of high pressure cylinder.	17 in.	18 in.	18 in.	17 in.	19 in.	18 in.
Stroke of piston.	26 in.	26 in.	26 in.	26 in.	26 in.	26 in.
Kind of piston.	"C. I." box.	"C. I." box.	"C. I." box.	"C. I." box.	"C. I." box.	"C. I." box.
Horizontal thickness of H. P. piston head in the center.	4 1/2 in.	4 1/2 in.	4 1/2 in.	4 1/2 in.	4 1/2 in.	4 1/2 in.
Kind of piston packing.	"C. I." rings	"C. I." rings	"C. I." rings	"C. I." rings	"C. I." rings	"C. I." rings
Diameter of H. P. piston rod.	3 1/2 in.	3 1/2 in.	3 1/2 in.	3 1/2 in.	3 1/2 in.	3 1/2 in.
Size of H. P. steam ports.	16 in. x 1 1/4 in.	18 in. x 1 1/4 in.	16 in. x 1 1/4 in.	16 in. x 1 1/4 in.	18 in. x 1 1/4 in.	16 in. x 1 1/4 in.
Size of H. P. exhaust.	10 in. x 3 in.	18 in. x 3 1/4 in.	16 in. x 3 in.	16 in. x 3 in.	18 in. x 3 in.	16 in. x 3 1/4 in.
Greatest travel of slide valves.	5 1/2 in.	5 1/2 in.	5 1/2 in.	5 1/2 in.	5 1/2 in.	5 1/2 in.
Throw of eccentrics.	5 1/2 in.	5 1/2 in.	5 1/2 in.	5 1/2 in.	5 1/2 in.	5 1/2 in.
Inside lap of H. P. slide valve (or inside clearance).	1 1/2 in.	1 1/2 in.	1 1/2 in.	1 1/2 in.	1 1/2 in.	1 1/2 in.
Outside lap of H. P. slide valve.	1 1/2 in.	1 1/2 in.	1 1/2 in.	1 1/2 in.	1 1/2 in.	1 1/2 in.
Lead of H. P. slide valve in full gear.	1/4 in.	1/4 in.	1/4 in.	1/4 in.	1/4 in.	1/4 in.
Throw of upper end of reverse lever from full gear forward to full gear backward, measured on the chord of the arc of its throw.	4 ft. 1 1/2 in.	4 ft. 1 1/2 in.	4 ft. 1 1/2 in.	4 ft. 5 1/2 in.	3 ft. 1 1/2 in.	3 ft. 1 1/2 in.
Sectional area of opening of H. P. steam pipe.	15.9 sq. in.	17.72 sq. in.	16.80 sq. in.	15.9 sq. in.	23.76 sq. in.	17.72 sq. in.
Area of "dry" pipe.	28.29	28.29	28.29	28.29	4.25	28.29
Cubic capacity of receiver.	4.25	4.25	4.25	4.25	4.25	4.25

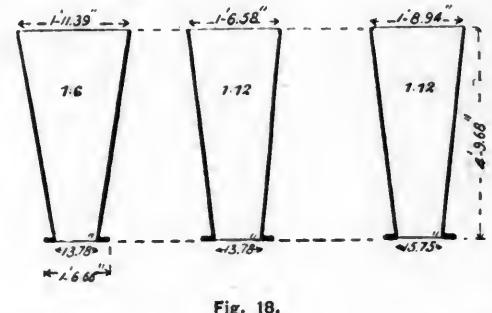
WHEELS AND AXLES.						
Diameter of driving wheels, outside of tire.	5 ft. 2 in.	6 ft. 1 1/2 in.	6 ft. 6 in.	5 ft. 2 in.	5 ft. 2 in.	5 ft. 2 in.
Material of centers and style of tire fastenings.	"C. I. Mansell" clip.	"C. I. Mansell" clip.	"W. I." forged spoke, Beattie clip and tire bolts.	"C. I." tire bolts.	"C. I. Mansell" clip.	"C. I. Mansell" clip.
Diameter of front truck wheels, outside of tire.	33 in.	37 in.	37 in.	33 in.	37 in.	37 in.
Material of centers and style of tire fastenings.	"C. I. Mansell" clip.	"C. I. Mansell" clip.	"W. I." forged spoke, Beattie clip and tire bolts.	"C. I. Mansell" clip.	"C. I. Mansell" clip.	"C. I. Mansell" clip.
Diameter of back truck wheels, outside of tire.	33 in.	37 in.	37 in.	33 in.	37 in.	37 in.
Material of centers and style of tire fastenings.	"C. I. Mansell" clip.	"C. I. Mansell" clip.	"W. I." forged spoke, Beattie clip and tire bolts.	"C. I. Mansell" clip.	"C. I. Mansell" clip.	"C. I. Mansell" clip.
Size of front driving axle journals, diameter x length.	7 in. x 8 in.	8 in. x 9 in.	8 in. x 9 in.	7 in. x 8 in.	7 in. x 8 in.	7 in. x 8 in.
Size of back driving axle journals, diameter x length.	4 1/2 in. x 7 1/2 in.	5 1/2 in. x 10 in.	5 1/2 in. x 10 in.	4 1/2 in. x 7 1/2 in.	5 1/2 in. x 10 in.	5 1/2 in. x 10 in.
Size of front truck axle journals, diameter x length.	5 1/2 in. x 10 in.	5 1/2 in. x 10 in.	5 1/2 in. x 10 in.	5 1/2 in. x 10 in.	5 1/2 in. x 10 in.	5 1/2 in. x 10 in.
Size of back truck axle journals, diameter x length.	5 1/2 in. x 10 in.	5 1/2 in. x 10 in.	5 1/2 in. x 10 in.	5 1/2 in. x 10 in.	5 1/2 in. x 10 in.	5 1/2 in. x 10 in.
Size of front coupling rod.	3 1/2 in. x 3 1/2 in.	3 1/2 in. x 3 1/2 in.	3 1/2 in. x 3 1/2 in.	3 1/2 in. x 3 1/2 in.	3 1/2 in. x 3 1/2 in.	3 1/2 in. x 3 1/2 in.
Size of back coupling rod.	3 1/2 in. x 3 1/2 in.	3 1/2 in. x 3 1/2 in.	3 1/2 in. x 3 1/2 in.	3 1/2 in. x 3 1/2 in.	3 1/2 in. x 3 1/2 in.	3 1/2 in. x 3 1/2 in.
Length of front truck springs, center to center of hangers.	3 1/2 in. x 1 1/2 in.	3 1/2 in. x 1 1/2 in.	3 1/2 in. x 1 1/2 in.	3 1/2 in. x 1 1/2 in.	3 1/2 in. x 1 1/2 in.	3 1/2 in. x 1 1/2 in.
Section of steel.	3 1/2 in. x 1 1/2 in.	3 1/2 in. x 1 1/2 in.	3 1/2 in. x 1 1/2 in.	3 1/2 in. x 1 1/2 in.	3 1/2 in. x 1 1/2 in.	3 1/2 in. x 1 1/2 in.
Length of driving springs, center to center of hangers.	3 1/2 in. x 1 1/2 in.	3 1/2 in. x 1 1/2 in.	3 1/2 in. x 1 1/2 in.	3 1/2 in. x 1 1/2 in.	3 1/2 in. x 1 1/2 in.	3 1/2 in. x 1 1/2 in.
Section of steel.	3 1/2 in. x 1 1/2 in.	3 1/2 in. x 1 1/2 in.	3 1/2 in. x 1 1/2 in.	3 1/2 in. x 1 1/2 in.	3 1/2 in. x 1 1/2 in.	3 1/2 in. x 1 1/2 in.
Length of back truck springs, center to center of hangers.	3 1/2 in. x 1 1/2 in.	3 1/2 in. x 1 1/2 in.	3 1/2 in. x 1 1/2 in.	3 1/2 in. x 1 1/2 in.	3 1/2 in. x 1 1/2 in.	3 1/2 in. x 1 1/2 in.
Section of steel.	3 1/2 in. x 1 1/2 in.	3 1/2 in. x 1 1/2 in.	3 1/2 in. x 1 1/2 in.	3 1/2 in. x 1 1/2 in.	3 1/2 in. x 1 1/2 in.	3 1/2 in. x 1 1/2 in.
Length of back truck springs, center to center of hangers.	3 1/2 in. x 1 1/2 in.	3 1/2 in. x 1 1/2 in.	3 1/2 in. x 1 1/2 in.	3 1/2 in. x 1 1/2 in.	3 1/2 in. x 1 1/2 in.	3 1/2 in. x 1 1/2 in.
Section of steel.	3 1/2 in. x 1 1/2 in.	3 1/2 in. x 1 1/2 in.	3 1/2 in. x 1 1/2 in.	3 1/2 in. x 1 1/2 in.	3 1/2 in. x 1 1/2 in.	3 1/2 in. x 1 1/2 in.

BOILER.						
Description of boiler.	Straight back.	Straight back.	Straight back.	Straight back.	Straight back.	Straight back.
Inside diameter of smallest ring of boiler.	4 ft. 0 1/2 in.	4 ft. 2 1/2 in.	4 ft. 2 1/2 in.	4 ft. 0 1/2 in.	4 ft. 2 1/2 in.	4 ft. 2 1/2 in.
Material of barrel of boiler.	Steel.	Steel.	"Bowling" iron.	"Bowling" iron.	Steel.	Steel.
Length of barrel from back of front tube plate to front of throat.	10 ft. 4 in.	11 ft. 10 1/2 in.	11 ft. 10 1/2 in.	10 ft. 4 in.	11 ft. 2 1/2 in.	11 ft. 2 1/2 in.
Thickness of plates in barrel of boiler.	1 1/2 in.	1 1/2 in.	1 1/2 in.	1 1/2 in.	1 1/2 in.	1 1/2 in.
Kind of horizontal seams.	Butt, inside and outside welds, double riveted.	Butt, inside and outside welds, double riveted.	Butt, inside and outside welds, double riveted.	Lap, double riveted.	Butt, inside and outside welds, double riveted.	Butt, inside and outside welds, double riveted.
" circumferential seams.	Lap, double riveted.	Lap, double riveted.	Butt, with weld outside and single riveted.	Lap, double riveted.	Lap, double riveted.	Lap, double riveted.
Material of tubes.	Charcoal iron.	Charcoal iron.	Charcoal iron.	Charcoal iron.	Charcoal iron.	Charcoal iron.
Number of tubes.	173.	190.	212.	190.	190.	190.
Diameter of tubes.	1 1/2 in.	1 1/2 in.	1 1/2 in.	1 1/2 in.	1 1/2 in.	1 1/2 in.
Distance between centers of tubes.	2 1/2 in.	2 1/2 in.	2 1/2 in.	2 1/2 in.	2 1/2 in.	2 1/2 in.
Length of tubes over tube plates.	10 ft. 8 1/2 in.	12 ft. 5 1/2 in.	12 ft. 5 1/2 in.	10 ft. 8 1/2 in.	11 ft. 9 1/2 in.	11 ft. 9 1/2 in.
Length of tubes outside firebox.	6' 6"	6' 6"	6' 6"	6' 6"	6' 6"	6' 6"
Width of firebox outside.	Mean, 3 ft. 10 1/4 in.	Mean, 3 ft. 10 1/4 in.	Mean, 3 ft. 10 1/4 in.	Mean, 3 ft. 10 1/4 in.	Mean, 3 ft. 10 1/4 in.	Mean, 3 ft. 10 1/4 in.
Length of firebox inside at foundation ring.	5 ft. 6 1/2 in.	5 ft. 6 1/2 in.	5 ft. 6 1/2 in.	5 ft. 6 1/2 in.	5 ft. 6 1/2 in.	5 ft. 6 1/2 in.
Width of firebox inside at foundation ring.	Mean, 3 ft. 2 1/2 in.	Mean, 3 ft. 2 1/2 in.	Mean, 3 ft. 2 1/2 in.	Mean, 3 ft. 2 1/2 in.	Mean, 3 ft. 2 1/2 in.	Mean, 3 ft. 2 1/2 in.
Depth of firebox from bottom of foundation ring.	3 in.	3 in.	3 in.	3 in.	3 in.	3 in.
Water space, sides of firebox at foundation ring.	3 in.	3 in.	3 in.	3 in.	3 in.	3 in.
Material of outside shell of firebox.	Steel.	Steel.	"Bowling" iron.	"Bowling" iron.	Steel.	Steel.
Thickness of plates of outside shell of firebox—throat, face, sides, saddle.	1/2 in.	1/2 in.	1/2 in.	1/2 in.	1/2 in.	1/2 in.
Material of inside of firebox.	Steel.	Steel.	Steel.	Steel.	Steel.	Steel.
Thickness of side sheets of firebox.	3/8 in.	3/8 in.	3/8 in.	3/8 in.	3/8 in.	3/8 in.
Thickness of back sheet.	3/8 in.	3/8 in.	3/8 in.	3/8 in.	3/8 in.	3/8 in.
Thickness of crown sheet.	3/8 in.	3/8 in.	3/8 in.	3/8 in.	3/8 in.	3/8 in.
Material of front tube sheet.	Steel.	Steel.	"Bowling" iron.	"Bowling" iron.	Steel.	Steel.
Thickness of front tube sheet.	3/8 in.	3/8 in.	3/8 in.	3/8 in.	3/8 in.	3/8 in.
How crown sheet is stayed.	Radial, 1 1/2 in. diameter.	Radial, 1 1/2 in. diameter.	Radial, 1 1/2 in. diameter.	Radial, 1 1/2 in. diameter.	Radial, 1 1/2 in. diameter.	Radial, 1 1/2 in. diameter.
Diameter of dome inside.	2 ft. 1 in.	2 ft. 1 in.	2 ft. 1 in.	2 ft. 1 in.	2 ft. 1 in.	2 ft. 1 in.
Height of dome to joint face.	2' 9"	2' 9"	2' 9"	2' 9"	2' 9"	2' 9"
Extension smokebox, outside diameter by length from joint face of front to face of tube sheet.	4 ft. 5 1/2 in. x 5 ft. 3 1/2 in.	5 ft. 0 in. x 5 ft. 8 1/2 in.	5 ft. 0 in. x 5 ft. 8 1/2 in.	4 ft. 5 1/2 in. x 5 ft. 3 1/2 in.	5 ft. 0 in. x 5 ft. 8 1/2 in.	5 ft. 0 in. x 5 ft. 8 1/2 in.
Maximum working pressure per square inch.	140.	180.	180.	140.	180.	180.
Kind of grate.	"C. I." rocking.	"C. I." rocking.	"C. I." rocking.	"C. I." rocking.	"C. I." rocking.	"C. I." rocking.
Width of grate bars.	1/4 in. at points and 3/4 in. at root.	1/4 in. at points and 3/4 in. at root.	1/4 in. at points and 3/4 in. at root.	1/4 in. at points and 3/4 in. at root.	1/4 in. at points and 3/4 in. at root.	1/4 in. at points and 3/4 in. at root.
Grate area.	17.85 sq. ft.	18.25 sq. ft.	17.75 sq. ft.	17.85 sq. ft.	18.25 sq. ft.	18.25 sq. ft.
Heating surface, firebox.	38.50	106.50	119.50	38.50	106.50	106.50
Heating surface, outside of tubes.	348.00	1,077.35	1,184.07	348.00	1,077.35	1,077.35
Effective cross sectional area through tubes.	2.21	2.44	2.71	2.21	2.44	2.44
Kind of blast nozzle.	Single.	Single.	Single.	Single.	Single.	Single.
Diameter of blast nozzle.	4 in.	4 in.	4 in.	4 in.	4 in.	4 in.
Smallest inside diameter of stack.	1 ft. 3 1/2 in.	1 ft. 3 1/2 in.	1 ft. 3 1/2 in.	1 ft. 3 1/2 in.	1 ft. 3 1/2 in.	1 ft. 3 1/2 in.
Height from top of rail to top of stack.	13' 3"	14' 0"	14' 0"	13' 3"	14' 0"	14' 0"
Style of frames.	Bar in front and elab at back.	Bar throughout.	Bar throughout.	Bar in front and elab at back.	Bar throughout.	Bar throughout.
" driver brakes.	American equalized on drivers and trailers.	American equalized on drivers and trailers.	None.	None.	None.	None.
System of sanding.	"Gresham's" patent steam sanding for D. & T.	Holden & Brook's Combination, 1892, Nos. 8 and 9.	"Gresham's" patent.	Ordinary, by hand.	Ordinary, by hand.	Ordinary, by hand.
Style and size of injectors.	G. T. R. Nos. 7 and 8.	Holden & Brook's Combination, 1892, Nos. 8 and 9.	G. T. R. Nos. 6 and 9.	G. T. R. Nos. 7 and 8.	Holden & Brook's Combination, 1892, Nos. 8 and 9.	G. T. R. Nos. 8 and 9.
Engines are fitted with baffle plates, firebrick arches and water tubes for carrying same.	Suburban, 1,500 gals. 33 cu. ft.	Express.	Express.	Light passenger.	Freight.	Freight.
Service for which engine is intended.						
Water capacity of side and back tanks in gallons of 231 cubic inches.						
Capacity of coal space, cubic feet.						

(d) Five conical stacks with an inclination of $\frac{1}{2}$ and the same minimum diameter, as shown in Fig. 17:
(e) Three funnel-shaped stacks (without a waist), of which one had an inclination of $\frac{1}{2}$ and a minimum diameter of 13.78 inches, and two having inclinations of $\frac{1}{2}$ and minimum



in the open, while the apparatus was in blast, would not have been possible, since the outrushing steam made an ear-bursting racket, and the stack emitted the hot condensation of the steam, while showers of water prevailed all about.



diameters of 13.78 inches and 15.75 inches, as shown in Fig. 18.
In the steam pipe leading from the boiler to the apparatus, which had a diameter of 2.70 inches, a cut-off valve, a throttle valve and a metallic manometer were placed. The throttle valve was fastened in a convenient

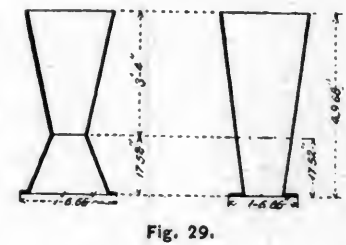
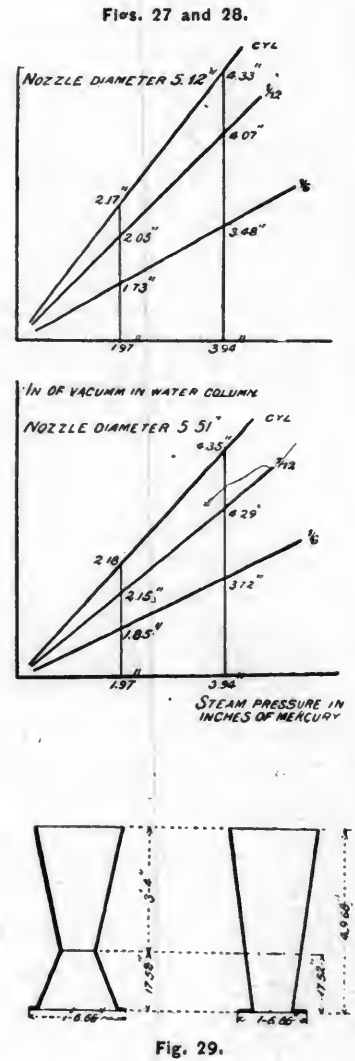
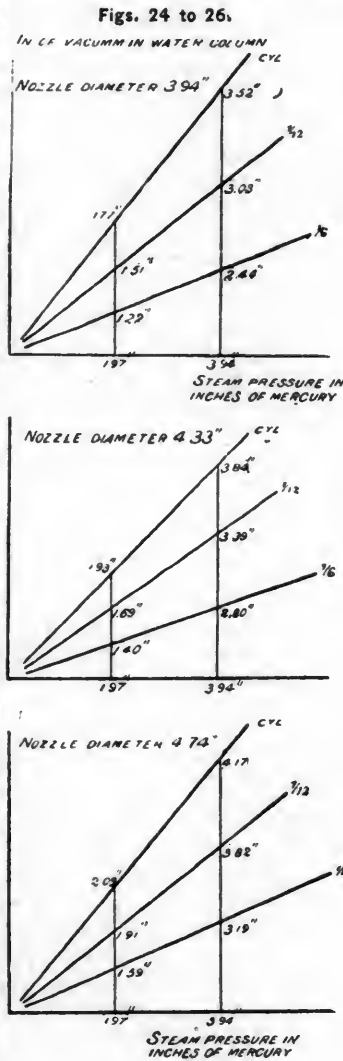
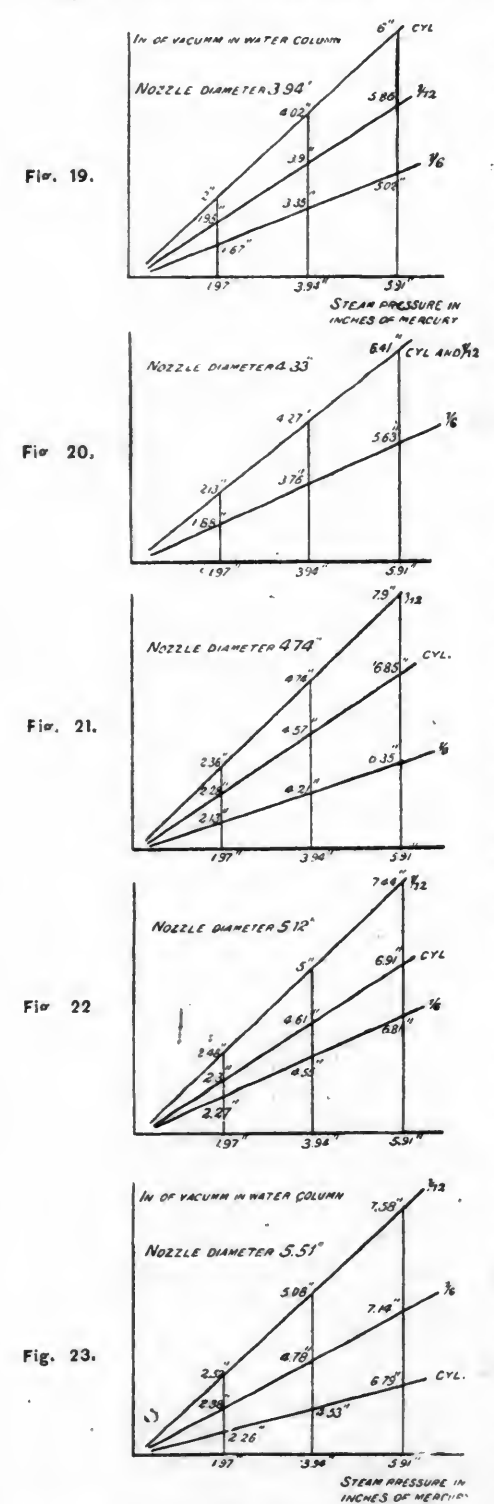
Before an experiment began the apparatus, whose steam chamber was well protected by a thick layer of felt against cooling, was thoroughly warmed. The water of condensation of this chamber was carried off by a pipe that was left was held within the limits of from 67 pounds to 75 pounds per square inch. In order that this great outpouring of steam might be maintained it was found necessary to force all three boilers of a neighboring battery up to their full power, though ordinarily they served to supply steam to a small steam engine and several steam hammers. With only two boilers in service, though the fires might be burning briskly, the steam pressure would gradually drop as much as four inches in the mercury column, which rendered accuracy in the results impossible; though this same variation was not observable in the metallic gage. This is offered in explanation of the contradictory results obtained by the Prüssmann experiments. While with him the pressure of the very small amount of steam emitted was measured by a sensitive instrument, the small variations of boiler pressure were allowed to pass unheeded, though they had the greatest influence upon the amount of steam emitted; in the Hanover experiments the great outflow of steam was controlled by a delicate instrument. In consequence of the latter condition, and the making of a great number of observations, for in all more than thirty thousand readings were taken, the values obtained showed a very uniform open during the experiment. By means of the throttle valve the pressure in the steam chamber was kept at the same height while the blast was in operation. The metallic gage served to indicate the pressure existing in the boilers which course when plotted in the form of a diagram. The variation of the maximum and minimum values from the basis established by the general average was, in the majority of cases, about .04 inch at the most, and seldom ran as high as from .08 inch to .12 inch. The observations repeated in different months gave the same ratios with the same stacks, and always the same vacuum was reproduced. The temperature of the air only had an influence upon the results in so far as that the readings taken during the colder months for each position of the blast pipe fell from .12 inch to .2 inch lower than when the weather was warm, due to the fact that the current of steam clung more closely to the sides of the stack. This affects, then, only the boundary limits of the dropping ends of the curves, and consequently the position of the nozzle, which is not changed in practice, and is, therefore, of no importance in connection with the respective stacks.
We next took up the task of establishing the relationship existing between the pressure in the blast-pipe and the vacuum. Already in his experiments with a locomotive under steam but stationary, Clark had obtained results sufficient to prove the proposition that the vacuum stands in a direct ratio to the blast-pipe pressure. This was investigated with the apparatus with stacks having the greatest variations of diameter and length and with all five

of the blast nozzles, and was found to be in exact correspondence in every instance.
If we take the blast-pipe pressure as abscissas and the corresponding vacuums as ordinates, the end points of the latter will form straight lines. In Figs. 19 to 23 these diagrams are given for the operation of a stack having a diameter of 13.78 inches. The blast-pipe position for all 15 of the readings was the same, or 1 foot 10 inches. Equal abscissas correspond to equal steam pressures. If the latter were twice, four times, or five times as great, the vacuum would increase twofold, fourfold, or fivefold, as the case might be.
The amount of steam issuing forth increases as the diameter of the nozzle is made larger, about in the ratio of the square of the diameter of the nozzle. If we consider that the amount of steam issuing from a nozzle 4 inches in diameter to be equal to 1, it follows that, with the same steam pressure and a

Nozzle diameter = 4 inches, the steam delivered = 1.00
" " = 4.4 " " " = 1.21
" " = 4.8 " " " = 1.44
" " = 5.2 " " " = 1.69
" " = 5.6 " " " = 1.96

Notwithstanding the fact that with a nozzle diameter of 5.6 inches, nearly twice as much steam is delivered as would be through one only 4 inches in diameter, a casual comparison of these five diagrams shows that the vacuum rises in a far smaller ratio.

To make this still clearer, the following figures are brought together.



Diameter of stack.	Shape of stack.	Increase in the vacuum with the nozzle located at 22 in., if the nozzle diameter is opened from 4 in. to 5.6 in.
13.78 in....	Cylindrical....	From 4.08 to 4.6 in. = .52 in. = 12.7 per cent.
	Conical 1/2....	" 3.96 " 4.14 " = 1.18 " = 30.7 "
	Conical 1/12....	" 3.4 " 4.34 " = 1.44 " = 42.3 "
15.75 "....	Cylindrical....	" 3.58 " 4.42 " = .84 " = 23.4 "
	Conical 1/2....	" 3.08 " 4.36 " = 1.28 " = 41.5 "
	Conical 1/12....	" 4.88 " 3.78 " = 1.1 " = 52.4 "

Hence, if the outflow of steam increases by about 100 per cent., the vacuum (under this ratio) will increase about 52 per cent., the shape of the stack remaining the same.
From these five diagrammatic representations we can readily see, without any further demonstration, how a cylindrical stack having a diameter of 13.78 inches falls off in its action with the same amount of steam as compared with the conical stack. With a nozzle diameter of 4 inches the cylindrical form seems to be the best when taken in connection with the height of the vacuum; at a diameter of 4.4 inches it nearly coincides with the conical form having an inclination of one-twelfth; with a further opening of the blast nozzle it drops down below the last-named form, until at a diameter of 5.3 inches for the nozzle it has fallen even below the stack having an inclination of one-sixth.
In other respects the diagrams show that the action of the cylindrical stacks is very much better than that of the con-

position near to the apparatus where a wooden booth was set up, in which the measuring instruments were placed and from which the apparatus itself could be readily watched through a window. A reading of the instruments

cal if we take stacks having a larger diameter than 13.78 inches. It so happens, then, that under the same ratios as shown in Figs. 19 to 23, that with stacks having a diameter of 14.76 inches, the cylindrical stack first coincides with the conical stack having an inclination of one-twelfth when the nozzle has a diameter of 5.06 inches. With a diameter of 15.75 inches, as well as with all five diameters of nozzle, the cylindrical form is superior to the conical (the nozzle position being 1 foot 10 inches) as is shown by Figs. 24 to 28.

We next have to show the reason why we believe, from the results obtained from the experimental apparatus, that a cylindrical stack 13.78 inches in diameter and 4 feet 9.08 inches high, is too small to be used with a nozzle 4.33 inches in diameter, just as a stack of 14.76 inches in diameter is too small for a nozzle having a diameter of 5.06 inches or more. And we are inevitably led to the further conclusion that the cylindrical stack, as being also superior at the smallest cross-section, must be preferred to the conical stack if we expect to maintain the same vacuum with the two forms under the same conditions. Likewise the conical stack should be given different inclinations, and the narrow inclination of $\frac{1}{12}$ be increased to $\frac{1}{8}$, as shown later in Section X.

Finally, we can state, as a well-defined conclusion, that the blast-pipe pressure has no influence upon the form of the stack, a conclusion that Prüssmann has already announced as the result of his experiments. Figs. 19 to 23 and 24 to 28 show this to be the case without the necessity of any further references; for the trend of the vacuum lines for the three different shapes of stacks maintains the same relationship to each other for all blast-pipe pressures, the nozzle diameters remaining the same. This position permits one to choose any steam pressure that may be desired for the experiments, even though it may not exactly correspond with the blast-pipe pressures as they exist in the locomotives. The Hanover experiments were now conducted with a steam pressure of 3.94 inches of the mercury column, a value which, as was afterward established, corresponded almost exactly with that existing on the standard passenger locomotives when running at a speed of from 34 to 37 miles per hour, a cut-off at .2 stroke, and exhausting through a nozzle of 4.74 inches in diameter. All of the experiments with the 18 stacks, of which 15 were in four different lengths, were made with this steam pressure, the openings into the air chamber remaining the same, and all other conditions being unchanged.

Each stack was tested with five different diameters of nozzle openings. In all there were 320 different combinations of stack and nozzle relations tested. In each of these relations there were at least 10 different positions of the nozzle employed and as many curve points marked with six readings each for the purpose of reaching a definite conclusion.

(To be Continued.)

The Holding Power of Lag Screws.

A correspondent in the *American Machinist* gives the following information concerning some experiments he made on the holding power of lag screws:

The holes were bored by a common carpenter's bit in 8-inch square logs, and the screws put in same as would be in common practice, and they were pulled out by the use of an Olsen testing machine.

Diameter of screw.	Diameter of bit.	Length of thread screwed into the wood.	Kind of wood.	The load at which screw pulled out.
$\frac{3}{4}$ inch.	$\frac{3}{4}$ inch.	3 inches.	Spruce	5,900 lbs.
"	"	"	"	5,900 "
"	"	"	"	6,100 "
"	"	"	"	9,000 "
"	"	"	"	9,500 "
"	"	"	Chestnut	9,500 "
"	"	"	"	7,000 "
"	"	"	Spruce	8,300 "
"	"	"	Pitchpine.	6,000 "
"	"	"	Spruce	3,500 "
"	"	"	"	1,900 "
"	"	"	"	700 "

This experiment seems to indicate that there is no advantage in using too small a bit when boring holes for lag screws. For instance, the $\frac{3}{4}$ inch screw required full as much force to pull out from a $\frac{3}{4}$ inch hole as it would take to pull out of a $\frac{1}{2}$ inch hole, although it is a great deal easier to put the screw in after a $\frac{1}{2}$ inch bit than it is after a $\frac{3}{4}$ inch bit, and it is certainly work spent in the wrong direction to use a bit smaller than the core of the screw.

By splitting the block and examining the wood around the screws, it will be found that when too small bits are used, the fibers in the wood around the screws are crushed and destroyed, but when the right size of bit is used the thread in the wood around the screw looks clean cut, the texture of the fibers is pressed and the fit in the wood on the screw resembles the appearance of a nut on a bolt.

When the $\frac{3}{4}$ inch screw was screwed into a $\frac{1}{2}$ inch hole its full length of thread, or five inches, it required a force of 9,000 pounds to pull it out; therefore it is safe enough for any temporary job under a steady stress to lift one ton in a $\frac{3}{4}$ inch lag screw, as this gives about four as factor of safety in pulling out of the wood, and there is no danger of pulling off the screw itself, because at the place of the core where it could break it is about $\frac{1}{4}$ inch, in diameter = 0.87 square inch area.

Assuming ultimate tensile strength to be 50,000 pounds per square inch, the breaking load would be 50,000 \times 0.87 = 18,500 pounds; thus there is no danger at all of the screw itself breaking for a load of a ton.

Gold's Improved Sealed Jet System of Hot Water Circulation.

A great improvement and advancement in a hot water circulating system for cars equipped with the Baker heater has been recently developed by Mr. Edward E. Gold, President of the Gold Car Heating Company.

The desirable and requisite feature of this style of equip-



Gold's Sealed Jet System of Hot Water Circulation.

ment has been to obtain a rapid circulation of the water through the pipes of the car.

The effects of the rapid circulation being the more effusive radiation of heat from the outgoing pipes of the coil, and in consequence the more thoroughly heated return.

When steam is let into the coil equipped with the Gold sealed jet, a complete circulation of the water takes place in from eight to eleven minutes, and in a correspondingly short length of time when fire is used.

Heretofore, on some few railways, it has been the practice to jet the steam into the water for the purpose of securing a more rapid circulation, but great objection has been made to this from the fact that it has been impossible to use salt water or other non-freezing liquids in the pipes when such steam or commingled jet is used. The result is that the use of fresh water is made necessary, and immediately the steam is shut off the jet or the fire extinguished the pipes are very liable to freeze and burst, and, in some cases, where the brakemen or porters have started a fire in the stove where the pipes were frozen the result has been some very terrific explosions, often blowing the car to pieces.

The Gold Sealed Jet, which can be used with any kind of water, whether fresh or salt, or the regular Gold patented non-freezing solution, the same as now being used in the Broadway cars, is a double extra heavy fitting, having some-

rise through the pipe J, it enters the jet at the opening C, passes around through the bend and owing to the taper of the nozzle is forced down the pipe with considerable energy. Any air which might be mingled with the water will rise to the drum as the water leaves the opening B.

The purpose of the $\frac{1}{4}$ inch tapping made into the nozzle at the upper side is to omit any particles of air that might settle in the jet proper when the pipes of the car are being filled with water. While this sealed jet can be used to great advantage on almost any system of hot water heating it has given its best results when used in connection with Gold's Duplex Double Coil which produces a double or divided circulation; one of the pipes running around one side of the car and the other on the opposite, as is also shown in the engraving. It will be noted that the apparatus is fitted with both the Gold Thermostatic Steam Trap and Gold's Improved Train Pipe Valve.

This Sealed Jet System has been found to work perfectly with either fire or steam and owing to the results that have been accomplished with it, it is now being rapidly applied to many cars equipped with a hot-water circulating system. It renders the fitting of a car with a Baker heater simple and easy and it is a compact fitting which produces its good results without any auxiliary drums or jackets to freeze or burst and become a hindrance to the car.

Many private cars belonging to railroad officials throughout the country have been fitted with this system which is giving the best results.

The Brownell Automatic Governor.

The accompanying illustrations show the governor used by The Brownell Co., of Dayton, O., on their Automatic Engines.

In the illustrations Fig. 1 is a view of the complete governor. In Fig. 2 the main eccentric is removed, showing the pin bolted to it, which fits into the hole in the auxiliary eccentric yoke. Fig. 3 shows this auxiliary eccentric yoke removed. The springs are also removed in this view.

As will be seen the governor has the usual arrangement

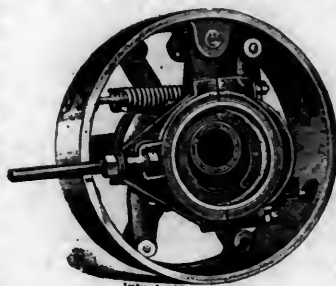


Fig. 1.



Fig. 2.

The Brownell Automatic Governor.

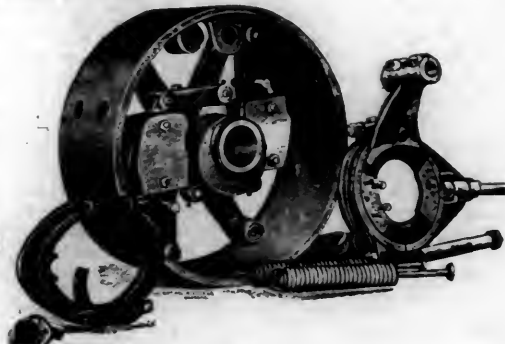


Fig. 3.

what the outward appearance of a back outlet return bend, but as can be seen from its sectional view in the accompanying illustration, one part of the bend is carried into the vertical section D, and this part so carried into the vertical section is slightly tapered like the nozzle of a water hose. At the upper end of this nozzle there is a small hole A, tapped to one-eighth inch.

In this condition the jet is connected with the expansion drum making only one connection into the drum. When steam is turned on the coil and the water begins to heat and

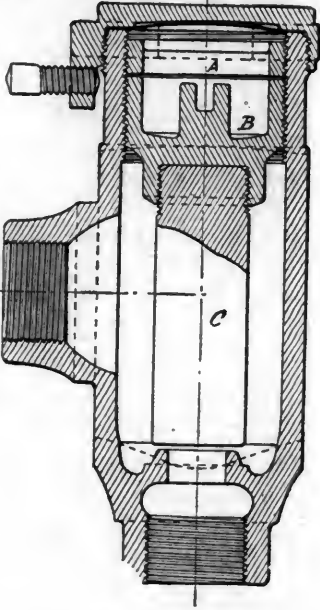
To reverse the governor, the pin bolted to the main eccentric is changed to the holes shown on the opposite side in Fig. 2, the weights and springs are changed to the holes provided for them, and the operation is complete. Engineers who have had to reverse some of the "Chinese Puzzles" on the market will appreciate the simplicity of this operation.

The governor is compact, yet all adjustable parts are very accessible. All wearing parts are circular in form, thus insuring smooth, uniform wear. The entire wear of the governor is taken up by two simple adjustments. The governor was designed and patented by H. C. C. Sup. of The Engineering Dept. of The Brownell Co.

The Diamond Steam Trap.

The steam trap which we herewith illustrate, by means of a longitudinal section, is one that is being made by Jenkins Bros., of 71 John street, New York. The principal upon which it acts is that a piece of metal expands as it is placed in contact with steam and closes the outlet, while as the water accumulates the metal cools, contracts and opens the outlet. The special arrangement of the mechanism is clearly shown in the engraving.

The steam connection is made at *D* and the outlet is at *E*. *C* is a plug of a special material that acts as the valve to close *D* by its own expansion. In adjusting the valve for service, steam is allowed to blow through it until all the parts are thoroughly heated, then the head *B* is screwed down until the expanding plug *C* is against its seat. It is



held in place by the cheek *A* and the whole covered and protected by a cap that is screwed down and held in position by a set screw. Then as the water accumulates in *D* and the interior of the valve cools the plug *C* contracts and allows the water of condensation to pass through and out, but by the time it has escaped the heat of the latter portion of the water or the steam that is following reheats the plug, causing it to again expand and close the opening at *D*.

Such a trap as this will take care of the water condensing in a line of 1-inch pipe 1,000 feet in length.

The wide range covered by the articles manufactured by the Trenton Iron Company is, perhaps, not generally known. One of their wide-spreading branches of specialities is the making of wire and wire ropes of all kinds, cable hoists, mine haulage and other equipments for the transportation of materials by means of wire rope. Then comes the other specialties of music wire, dress stays, corset, clock springs and umbrella wire, the quality of which is superior to that of imported brands, for quality rather than quantity is the object aimed at, and one evidence of this superior quality is to be found in the numerous awards granted them at the Columbian exposition in Chicago, where they had a large and interesting display, one feature being a coil of wire in one piece 33 miles long and weighing but 11 pounds. They have recently produced a special grade of resistance wire for electrical heaters that is meeting with great favor. Other lines are the locked wire rope, Bleicher's wire rope tramways and a bale tie known as the "Anchor" tie. To assist in the dissemination of information regarding the use of wire and wire rope they have published a little book entitled "Wire Rope Transportation in All its Branches," describing the different systems of wire rope tramways, cable hoists, surface and underground haulage plants, the equipments for which are manufactured by the company. It also contains descriptions of many of the lines built by them with illustrations taken from photographs. In addition to this it also contains considerable information of value to engineers. It is sent free on application.

The Q. & C. Co. have recently put a new wood preservative upon the market. The attention of the company was called to this in connection with its work in the development of the Servis plate. The new compound is known as the Q. & C. Carbolineum or wood preservative, but it is by no means an untried article, as it has been in use by several street and steam railroad companies for a number of years. The uses to which it can be applied are very numerous, and it will be found to be especially valuable to the car builder who can use it to great advantage either for car timbers or for the ends only, and for the floors of stock cars, while in other railroad work it will be useful in the construction of platforms, crossings, signal box, and in fact wherever either wet or dry rot is possible and finally it is claimed to be a sure preventive against the teredo.

CAMBERIA IRON COMPANY AND THE LATROBE STEEL COMPANY.—Mr. L. R. Pomeroy announces that he has been appointed sales agent for these two companies with an office at 33 Wall street, New York.

Messrs. Burnham Williams & Company announce that Messrs. Samuel M. Vanelein, Alba B. Johnson and George Burnham, Jr. were admitted into partnership in their firm on Jan. 1st.

Improved Freight Service South.

In keeping with the general policy adopted by the Southern Railway since its reorganization the management has instituted an entirely new freight service, which will, no doubt, be welcomed with delight by all Southern merchants and shippers. Taking effect on December 31, 1895, this road will operate both South and North bound in connection with the Old Dominion S. S. Company, from Pier 26, N. Y. R., New York City via Norfolk (Pinner's Point), Va., instead of via West Point, Va., as heretofore; and, while this change in itself is a valuable advantage, the officials have gone even further by introducing a daily steamer service from and to this port, which will be the means of their being able to make from 12 to 24 hours less on all freights to any point in the South and Southwest, as former service was only a tri-weekly one.

The freight lines thus operated are the Piedmont Air and Paint Rock Lines, both popular for years past as fast freight lines South.

The unswerving energy constantly displayed by the Southern Railway toward giving to the public the very best possible freight service available, will, no doubt, be amply rewarded and recognized by all shippers, in increased patronage over its various lines, and in the race for speed and dispatch, the Piedmont Air and Paint Rock Lines can, with the daily steamer of the Old Dominion Steamship Company, show a clean pair of heels to all competing lines to any points they reach.

Big Verdict Against Pullman.

Judge Butler filed an opinion in United States Circuit Court to-day, dismissing the exceptions to and confirming the report of Theodore M. Etting, the Master in the Central Transportation Company-Pullman Palace Car Company case. Under the finding there is an award of \$2,522,000 and eleven years' interest in favor of the Central Transportation Company.

The suit was brought by the Central Company to recover rentals, and it has been in litigation for a long while. Judge Butler said that the Master was appointed in pursuance of the opinion filed Dec. 18, 1894, to ascertain the value of the property transferred and the amount of its earnings. The Master found the value to be \$2,522,000, and reports that no estimate of earnings can be made from the data furnished, and that the Pullman Company failed to produce—though requested to do so—evidence in its possession.

The *Pilgrim* (holiday number) is full of bright sketches—prose, poetry and illustrations—by bright writers and artists. Entirely original, new and entertaining. Mailed free to any address on receipt of six (6) cents in postage stamps. Write to Geo. H. Heafford, publisher, 415 Old Colony Building, Chicago, Ill.

An enigmatical bill of fare, for a dinner served on the dining cars of the Chicago, Milwaukee & St. Paul Railway, will be sent to any address on receipt of a two-cent postage stamp. Apply to Geo. H. Heafford, General Passenger Agent, Old Colony Building, Chicago, Ill.

The passenger department of the New York Central & Hudson River Railroad has issued a pamphlet advertising New York as a winter resort. It contains 64 pages of information about hotels, theaters, shops, restaurants, notable buildings, localities, etc., and directions for getting about. There is an original map of New York, made expressly for the book, and is printed in colors. A copy will be sent free, post paid, to any address in the world on receipt of two 2-cent stamps, by George H. Daniels, General Passenger Agent, Grand Central Station, New York.

The Standard Boiler Company, of Chicago, report a good business during the past year. They have moved into their new offices, 1120 and 21 Marquette Building. These boilers are built by the well-known firm, Link-Belt Machine Company, of Chicago, who have put in new and improved machinery for their manufacture, reducing the prime cost as well as making the various parts interchangeable. During the past year a number of fine plants have been installed, among others being 4,000 horse power, for the North Chicago Street Railroad Company at their new power station at Hawthorn avenue. 500 horse power, for the Cincinnati Edison Company, at Cincinnati, O.; 600 horse power for the Western Electric Company, at their factory in Chicago, and various others. The report prospects for the coming year is good.

The Russell Wheel and Foundry Company are very busy in making logging cars; have orders ahead for two months. They make cars for special purposes, such as for soda ash work and for blast furnace works; also flat cars for street railway service.

A good-natured German, who was the prosperous proprietor of a considerable clothing business in a country town had in his employ a clerk named John, whom he had advanced from cash boy to head clerk, and who had for many years been an attaché of the store. Since his promotion John had several times asked for a raise in his salary, and each time his request had been granted. One morning John again appeared at the old merchant's desk with another request for an increase of \$10 per month. "Vy, Sohn," said the employer, "I tink I bays you putty vell alretty; vat for I bays you any more?" "Well," replied John, confidently "I am your principal helpere; I have worked you up a large trade; I know every detail of the business, and indeed I think you could not get along without me." "Is that so?" exclaimed the German, "Mein Gott! Shon, vot wud I do suppose you vas to die?" "Well," hesitated John, "I suppose you would have to get along without me then." The "old man" took several whiffs from his big pipe and said nothing. At last he gravely remarked: "Vell, Shon, I guess you petter gon-sider yourself dead."

Our Directory

OF OFFICIAL CHANGES IN JANUARY.

We note the following changes of officers since our last issue. Information relative to such changes is solicited.

Atlanta & West Point.—Mr. Robert T. Pace has been appointed Purchasing Agent for this road and the Western Railway of Alabama.

Atlantic & Pacific.—Mr. Charles W. Smith has been appointed Receiver to succeed Messrs. Aldace F. Walker and John J. McCook, who resigned a few weeks ago.

Augusta Southern.—James N. Jackson is President and General Manager; P. H. Langdon, Vice-President, and W. F. Scofield, Superintendent, Secretary and Treasurer.

Boston & Maine.—General Manager T. A. Mackinnon has been appointed First Vice-President with authority over the operative and constructive departments. Division Superintendent Geo. F. Evans has been appointed Assistant General Manager, with headquarters at Boston, and Assistant Division Superintendent William G. Bean has been appointed Superintendent of the Southern Division with headquarters at Boston.

Baltimore & Lehigh.—Mr. G. W. Seidel has been appointed Master Mechanic, with headquarters at Baltimore, Md.

Chateaugay.—W. W. Conaughty has been appointed Superintendent.

Chicago & Great Western.—Purchasing Agent James Warwick has resigned.

Chicago, Rock Island & Pacific.—Foreman of Car Department George Heenan has been appointed General Car Inspector, with headquarters at Grand Junction, Colo.

Chicago & Eastern Illinois.—Mr. Thomas A. Lawes has been appointed Superintendent of Motive Power to succeed Mr. Allen Cooke, resigned.

Cleveland, Cincinnati, Chicago & St. Louis.—George Tozer has been appointed Purchasing Agent.

East Broad Top.—Acting Superintendent A. W. Greenwood has been appointed Superintendent.

Erie.—General Foreman Willard Kells, of the Meadville, Pa., shops, has been appointed Master Mechanic of the Cleveland shops.

Master Mechanic George Donabne has been transferred from the Cleveland shops to Meadville, Pa.

Erie Lines West.—Col. A. M. Tucker will hereafter have the title of General Agent with headquarters at Cleveland.

Forest City & Sioux City.—John F. Way has been appointed Receiver.

Galveston, La Porte & Houston.—Messrs. T. W. House and M. T. Jones have been appointed Receivers.

Great Northern of England.—Mr. H. A. Ivatt has been appointed Locomotive Superintendent to succeed Mr. Patrick Sterling, deceased.

Hosac Tunnel & Western.—Mr. W. D. McNeill has been appointed Master Mechanic, with headquarters at Resaboro, N. Y.

Hutchinson & Southern.—Mr. L. E. Walker has been appointed Receiver.

Illinois Central.—Assistant Superintendent of Motive Power J. J. Casey has resigned.

Indiana, Decatur & Western.—The following appointments are announced: President, — Woodford; Treasurer, F. H. Short; Auditor, G. W. Lishawa; Secretary and Purchasing Agent, George R. Balch.

Kansas City, Fort Scott & Memphis.—Freight Traffic Manager E. S. Washburn has been made Vice-President, his former office having been abolished.

Kansas City, Pittsburg & Gulf.—Mr. Ira C. Hubbell has been appointed Purchasing Agent. His duties also embrace the Texarkana & Fort Smith, and Kansas City & Independent Air Line.

Keokuk & Western.—Trainmaster J. P. Boyle has been appointed Superintendent, with headquarters at Keokuk, Iowa.

Lima Northern.—Mr. C. W. Risley has been appointed Superintendent, with headquarters at Lima.

Macon & Birmingham.—Mr. J. R. Lane has been appointed Superintendent of Transportation, Roadway and Machinery.

Missouri, Kansas & Texas.—Superintendent of Motive Power William O'Herin has been made Superintendent of Machinery and Equipment, and will have charge of both the locomotive and the car departments. The office of Superintendent of Car Department is abolished, and Mr. John Doyle has been appointed General Master Car Builder.

Nevada Southern.—R. S. Seibert is Receiver and General Manager, with office at Los Angeles, Cal.; L. Vanderwerker is General Agent for Beach, with office at Manvel, Cal.

New York & Sea Beach.—Treasurer James T. Nelson has been appointed Receiver.

Florida Southern.—Mr. W. H. Young has been appointed Master Mechanic.

Pecos Valley.—General Manager J. N. Miller has resigned and will be succeeded by Mr. E. O. Faulkner, who has been elected Vice-President and General Manager.

Port Jervis, Monticello & New York.—The following appointments are announced: President, Thomas Waller; Vice-President, George N. McKibben; Secretary, Frederick C. Reed, and Treasurer, S. Harrison Wagner.

Rock Island & Peoria.—Mr. Hiram S. Cable has been chosen Vice-President.

St. Louis, Alton & Terre Haute.—Assistant General Manager C. F. Parker has been appointed General Manager.

St. Louis, Kennett & Southern.—L. B. Houck has been appointed Superintendent with office at Caruthersville, Mo.

Seaboard Air Line.—Mr. James Warwick has been appointed General Purchasing Agent.

South Haven & Eastern.—General Manager R. H. England has resigned and will be succeeded by Mr. M. V. Meredith, of Saginaw, Mich., formerly a Division Superintendent on the Flint & Pere Marquette.

Spokane Falls & Northern.—Assistant General Manager Austin Corbin 2d, has been promoted to General Manager.

Southern.—Mr. T. S. Inge has been appointed Master Mechanic at Burlington, N. C.

Terminal Railroad Association at St. Louis.—Yardmaster E. Dunlap has been appointed Acting Superintendent.

Vandalia Line.—President Wm. R. McKee, retired at the annual election. Superintendent J. J. Turner, of the Pittsburg, Cincinnati, Chicago & St. Louis, has been appointed Vice-President and General Manager.

Master Mechanic Wm. C. Arp, of the Pennsylvania Company, at Dennison, O., has been appointed Superintendent of Motive Power, with headquarters at Terre Haute, Ind.

Velasco Terminal.—Mr. L. L. Foster has been appointed Second Vice-President and General Manager.

Wheeling & Lake Erie.—Mr. F. C. Gates has been appointed Acting Purchasing Agent.

Employment.

A young man having a mechanical education is desirous of advancing by means of hard work and is open to an engagement as car or locomotive draftsman. He has a thorough knowledge of car construction, embracing all classes of cars used in passenger or freight service, including sleeping and parlor cars. He has had six years' experience in car drafting, latterly in charge of such work. He has a general and theoretical knowledge of locomotive work but no actual experience. References given. Address "DRAFTSMAN," care this paper.

AMERICAN ENGINEER CAR BUILDER AND RAILROAD JOURNAL

MARCH, 1896.

CONTENTS.

ILLUSTRATED ARTICLES:	Page.	EDITORIALS:	Page.
Twin-Hopper Gondola Car of 70,000 Pounds Capacity—Northern Pacific Road.	35	Action of Supreme Court in Westinghouse-Boydton Suit.	40
Motor Trucks and Motors for Lake Street Elevated Railway in Chicago.	35	The Patent Office for Manufacturing Methods.	40
Experiments on Locomotive with Firebox Lined with Fire-brick.	36	Operating Locomotives by the "Chain Gang" system.	40
Construction and Maintenance of Railway Car Equipment.	38	Fireboxes Lined with Fire-brick.	40
Passenger Locomotive for the Great Western Railway of England.	39	A New English Locomotive.	40
Box Car of 60,000 Pounds Capacity, with Steel Center Sills, C. B. & Q. R. R.	41	The Revised Rules of Interchange.	41
The Most Advantageous Dimensions for Locomotive Exhaust Pipes and Smokestacks.	45	MISCELLANEOUS:	
The New Baldwin-Westinghouse Electric Locomotive.	47	Paragraphs.	33
Centrifugal Sand Mixing Machine.	47	Communications.	34
		Water Tube Boilers in the British Navy.	39
		"Industry."	41
		Engineering News.	42
		Notes.	42
		Trade Catalogues.	42
		Personals.	43
		Daniel Kinnear Clark.	44
		Manufacturing Paragraphs.	48
		Our Directory.	48

The Lehigh Valley Railroad is in the market for 2,000 freight cars.

The Delaware, Lackawanna & Western will soon place orders for 1,000 freight cars.

The Central Vermont Railroad Company is having 13 passenger coaches built by Jackson & Sharp.

The Adirondack & St. Lawrence has ordered 10 locomotives from the Schenectady Locomotive Works.

It is stated that the Missouri, Kansas & Texas has decided to build new repair shops at Sedalia, Mo.

The Lake Superior and Ishpeming Railway has ordered 10 locomotives from the Pittsburg Locomotive Works.

An order for 400 ore cars for the Lake Superior & Ishpeming road, has been placed with Wells & French.

The Elliott Car Works, Gadsden, Ala., are building 150 freight cars for the Chattanooga, Rome & Columbus.

The Ohio River Railroad has ordered 300 cars from the Ensign Manufacturing Company, Huntington, W. Va.

The Chicago & North Western has ordered 100 furniture cars from the Haskell & Barker Car Co., Michigan City, Ind.

The Erie has ordered 1,700 cars from the Michigan-Penninsular Car Company and 500 from the Buffalo Car Company.

The Paris Gas Company is putting a Luhrig gas tram car on the Paris Omnibus Company's tramway lines by way of experiment.

The Pennsylvania Railroad Company has ordered the construction of 500 new gondola hopper coal cars at the Altoona shops.

The Wheeling & Lake Erie Railroad has ordered 1,000 freight cars from the Barney & Smith Car Company, Dayton, Ohio.

The Baldwin Locomotive Works has received an order, from the Cincinnati, Jackson & Mackinaw Railroad for five locomotives.

The Great Northern Railway Company is equipping its freight cars with the New York Air Brake Company's latest form of quick action air brake.

Rumors indicate that in the near future the Cincinnati, Jackson & Mackinaw road will give orders for a considerable number of locomotives.

The locomotives under construction in the works of the Grant Locomotive Works at the time of their failure have been completed by Siemens & Halske and are now for sale.

The South Baltimore Car Works has contracted to build 400 freight cars for the West Virginia & Pittsburgh Railroad Company, and 300 coal cars for several coal companies.

The Baldwin Locomotive Works has a contract for 32 additional locomotives to go to Russia. These engines will be 10-wheeled compound passenger engines and will burn naphtha.

The practice of taking the control of heating apparatus on sleeping cars from the porters and putting it in control of the train crew, is extending. Orders were recently issued on some divisions of the Pennsylvania transferring these duties to the trainmen.

The Lehigh Valley Railroad has ordered five heavy locomotives from the Baldwin Locomotive Works. The engines will have 22-inch by 28-inch cylinders, and are intended for service on heavy grades.

The boiler of a locomotive drawing the New York and Philadelphia express train on the Delaware, Lackawanna & Western Railroad exploded near Cassville, N. Y., Feb. 18, killing both the engineer and fireman.

The Brooks Locomotive Works has an order from the Northern Ohio for building six Mogul engines with 18-inch by 24-inch cylinders. These engines are duplicates of those for the Lake Erie & Western, which operates the Northern Ohio.

The Barney & Smith Manufacturing Company, of Dayton, O., will build for C. J. Hamlin, of Buffalo, a private car for the transportation of racehorses. It will be 62 feet long, and will be carried on six-wheeled trucks with steel-tired wheels.

The Chicago & Northwestern Railway is now equipping its freight cars with Westinghouse air brakes at the rate of 25 cars per day. The foundation brakes are at the same time thoroughly overhauled and made to conform to M. C. B. standards.

The New York Central has given an order for 2,150 freight cars, of which the Buffalo Car Company received 1,250, the Union Car Works 500, and the Barney & Smith Company 400. The first two allotments are coal cars, and the last platform cars.

The New York, Chicago & St. Louis has put into service the 10 new freight engines recently received from the Brooks Locomotive Works and the Schenectady Works, and are much pleased with them. They will soon receive three switchers from the same builders.

The 10 mogul locomotives ordered by the Illinois Central from the Brooks Locomotive Works will have 19-inch by 26-inch cylinders, Belpaire boilers 62 inches in diameter, driving wheels 56 inches in diameter and long fireboxes. The total weight of the engine will be about 125,000 pounds.

A policy of rigid economy has been decided upon by the new Atchison management in order to make a saving of at least \$1,000,000 a year. President Ripley is making a tour of inspection of that system with the sole purpose of noting the different points where the reductions can best be made. —San Francisco Bulletin.

Indian Engineering is authority for the statement that a German has been granted a 75 years' concession for the construction of a carriage road from Teheran to Bagdad. He has also obtained a 90 years' concession for a steam or electric tramway, 10 miles in length, from Teheran to the villages north of the city.

The Monterey & Mineral Belt Railway, of which ex-General Manager Robinson, of the Monterey & Mexican Gulf road, is one of the owners, is to be extended to Matehuala, a rich mining section south of Monterey. The road is now in operation a distance of 20 miles, and is doing a heavy ore business. —San Francisco Bulletin.

The new hospital for employees of the Atchison, Topeka & Santa Fe Railroad at Topeka has been opened. It is a large and handsome building, four stories high, and cost about \$125,000. The Santa Fe Hospital Association, supported by assessments upon the employees, was chartered in 1891. This association controls this hospital and also those at La Junta and Las Vegas.

The Westinghouse Electric & Manufacturing Company, is equipping the Turtle Creek Valley branch of the Pennsylvania Railroad with an overhead trolley wire to test Westinghouse-Baldwin electric locomotive. This branch runs from Brinton to Murraysville, Pa., and is about 11 miles long. The new locomotive is now at the Westinghouse Electric Company's Works.

The entire Pennsylvania system has adopted the practice of covering the handrails, cylinder-head casings, steamchest casings and other parts of locomotives with paint, instead of giving them a bright finish as has been the custom from time immemorial. The enginemen, it is said, are also required, much to their disgust, to take off the deer horns, stars and other unofficial ornaments that have decorated their engines in the past.

The Pennsylvania Railroad has issued orders for the construction of 38 new locomotives in the Altoona and Juniata shops. Six class "U" switch engines and 12 class "M" switching engines will be built at the Altoona shops, and eight class "L" heavy fast passenger engines and 12 new compound moguls will be built at the Juniata shops. A portion of the switching engines and moguls are intended for lines west of Pittsburg, and five of the new class "L" engines are for the Panhandle.

The Cosmopolitan Magazine offers \$3,000 in premiums which will be awarded to motor carriages exhibiting the greatest excellence in a trip to be made on Decoration Day, May 30, between City Hall Park and the Cosmopolitan Building at Irvington-on-Hudson. The round trip is about 52 miles. The following points will be considered in making the award: Speed, 50 points; simplicity and durability of construction, 25; ease in operating and safety, 15; cost, 10. Entries must be made before May.

The first official exhibition of the electric motors used to switch the cars on the Brooklyn Bridge was made February 8, in the presence of President Howell, Vice-President J. S. Page and Trustees Keeney and Henriques. The motor car was coupled to three of the ordinary passenger cars, mak-

ing a train of four cars which was switched by the motors from the incoming to the outgoing tracks and up to the cable sheaves several times. The car made two round trips over the bridge to the satisfaction of the officials present.

At a meeting of the shareholders of the Mount Yamalpais Scenic Railway Company, held early in February, Sidney B. Cushing was elected President; David McKay, Vice-President; Louis L. Janes, Secretary, and the First National Bank of San Francisco, Treasurer. A contract for grading and track laying was let to the California Construction Company and work has already begun. Contracts are about to be let for engines, boilers, dynamos and other requisites for generating power. Work on the power house will be commenced at once.

Some new machinery is being installed in the shops of the car department of the Lake Shore road. At Cleveland a new 105 horse power Buckeye engine having a cylinder, 14½ by 26 inches, will be put in, and also a No. 2 Fay dimension planer which can dress simultaneously four sides of a timber 20 by 26 inches and reduce the size 2 inches at one passage through the machine. At the Adrian shops a No. 2 Putnam wheel borer will be installed, and at the Englewood shops a No. 7 Greenlee hollow chiselmorticer, with straight and angle boring attachments.

The Lake Shore & Michigan Southern Railway placed car orders last month as follows: With the Michigan-Penninsular Car Company, 500 drop bottom coal cars of 60,000 pounds capacity and 500 standard box cars of 60,000 pounds capacity; with the Madison Car Company, 250 coal cars and 250 box cars; with the Wells & French Company, 250 box cars; with the Union Car Company, 250 coal and 100 box cars, which are to be lettered for the Pittsburgh & Lake Erie and to be delivered prior to May 1. All the other coal cars are also to be delivered prior to May 1, but the box cars are to be delivered during August and September.

Representatives of the Carnegie Steel Company and Bethlehem Iron Company appeared before the Senate Committee on naval affairs last month to protest against the enactment of Senator Smith's bill providing for the erection of a government armor-plate plant in Washington. These companies asserted that to equip such a plant would cost more than \$4,000,000, and they argued that in view of the fact that immense sums had been invested by private persons in this business at the suggestion of the Government, it would be unjust for the Government to render that outlay useless by the construction of competing works that could do the work no better and no cheaper.

The annual report to the stockholders of the Chicago & Alton Railroad, issued last month, shows the net earnings for 1895 to be \$2,819,493, an increase of \$155,944 compared with 1894. President Blackstone, in the report, takes occasion to declaim against what he terms popular control of railroads. He sets forth that the Supreme Court of the United States long ago held that the charter of a railroad corporation is a contract within the meaning of the contract clause of the constitution, but that the people have failed to remember their side of the contract. One of the provisions of such contracts is that railroads shall always have power to collect reasonable rates, but the state has passed a law enabling a state board to limit railway rates at their discretion.

It is reported that successful arrangements for preventing damage to merchandise through excessive cold have been experimented with on a German railroad. The winter 1894-5, which was particularly severe throughout Central Europe, caused great losses of perishable freight in transit during the winter months. It was, therefore, proposed to heat freight cars, carrying such goods. A stove in the center part of the car, which is fed from without, supplies the necessary warmth, and a thermometer, which is visible from the outside, reveals to the inspector, whose duty it is to ascertain the temperature of each car at every station, whether he has to open the ventilators on top to reduce the heat or whether new fuel ought to be introduced to keep up the fire and increase the temperature. A slight additional freight is charged, and as the shippers prefer this increase to the uncertainty of the weather, the entire system is said to have been pronounced a success on all sides.

Bradstreet's, in reviewing the gross earnings of railways in January, 1896, had the following to say regarding the large increase: "January gross earnings may be classed as very satisfactory, showing as they do a continuance and accentuation of previous favorable conditions and the practical disappearance of many unfavorable features which have marked gross earnings reports for the past few months. The total earnings of 126 railroads for January aggregate \$37,761,005, an increase over January a year ago of 11.3 per cent., this large gain being made on a total of \$2,766 miles, an amount which may be regarded as truly representative of the country's operated railroads. Not only is the gain shown in January in excess of that recorded for some time past, but the number of large increases is larger and decreases are smaller in number and in volume than for many months past. In fact, the month just closed makes a very welcome showing as regards the small number of decreases and the trifling volume of the declines shown from January a year ago."

Communications.

The Westinghouse Air-Brake Company versus The Boyden Brake Company.

Editor American Engineer, Car Builder and Railroad Journal:

The issue by the Boyden Brake Company of a circular dated December 31, 1895, in which that company asserts, among other misleading statements, that the decision of the Fourth Circuit Court of Appeals in favor of that company is final, makes it necessary for us to state that the United States Supreme Court has, upon petition of our counsel, based upon a few of the serious errors involved in that decision, granted a writ of certiorari directing the case to be sent up to it for revision and final judgment.

The Boyden Company's statement was manifestly prepared before the Supreme Court granted the writ of certiorari, and it will thus be seen that that company is not yet finally authorized to make and sell quick-action air-brake, without liability for infringement of our patent rights.

We have never doubted that the final decision in this case will reaffirm the validity of our pioneer quick-action air-brake patent (No. 300,070, the one in dispute,) as already established in other courts; for Judge Hughes, in his decision in favor of the Boyden Brake Company, says:

"That this invention of Westinghouse, thus undefined (the Court then referring to the second claim), is one of the highest value to the public, and that it is a pioneer one in the art of quick action brakes is not denied, and is conceded. It is conspicuously one of those pioneer inventions which entitle the proprietor to a liberal protection from the courts in construing the claim."

A statement in accord with the opinions of the other courts which have, in each instance, conceded and affirmed the pioneership and value of this invention.

In each of the three previous decisions in favor of this patent, the second claim has been upheld and has not, in any manner, been held to be insufficient, even in any technical sense, to fully cover the invention; and we therefore the more strongly feel that our confidence in the ultimate determination of this litigation in our favor is well founded.

The Boyden Brake Company has issued an illustration and description of a new form of quick action triple valve, which it states was subjected to a satisfactory rack test at Altoona, by the air-brake committee of the Master Car Builders' Association. This new valve has not hitherto been the subject of litigation under our patents and has never, to our knowledge, been commercially used or tested. We believe that the construction of this valve comes clearly within the claims of one of our patents, and we have promptly brought suit against the Boyden Company, to restrain that company from making and selling this new valve.

It will not be out of place to call attention to the fact that railway companies have, in numerous instances, been misled by the statements of various parties manufacturing brakes, in infringement of our rights, and the loss inflicted upon those who have purchased brake apparatus in reliance upon those statements has already been very great. We feel convinced that we are fully justified in believing that our patents fully cover all of the forms of quick-action brakes which have so far been offered for sale, and that the courts will finally so decide.

THE WESTINGHOUSE AIR BRAKE COMPANY,
H. H. WESTINGHOUSE, General Manager.

Pittsburgh, Pa., Feb. 1, 1896.

Laird Crossheads.

Editor American Engineer, Car Builder and Railroad Journal:

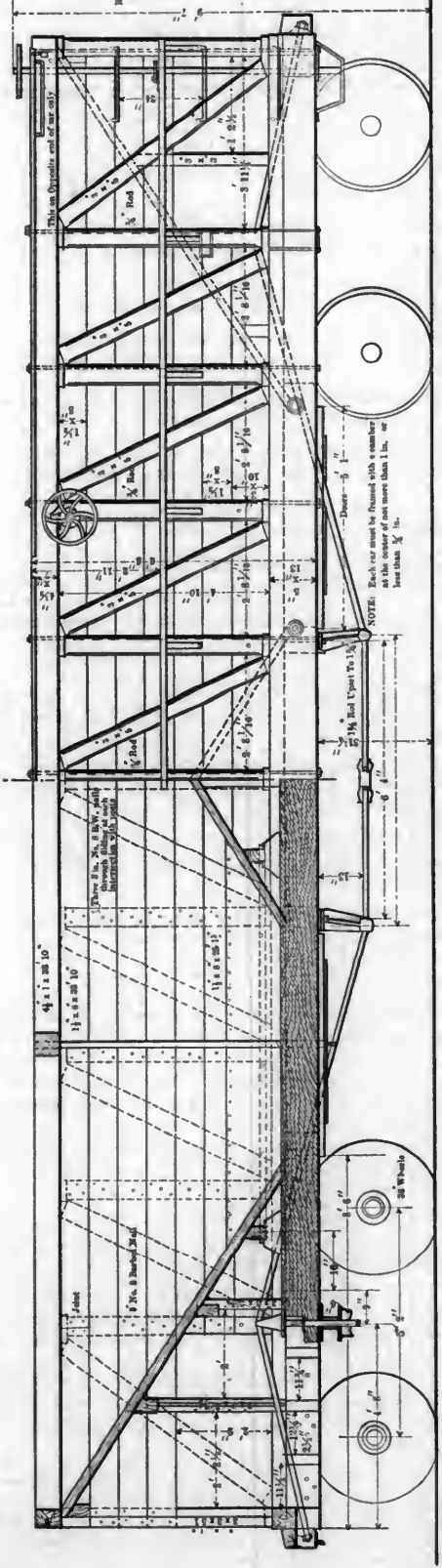
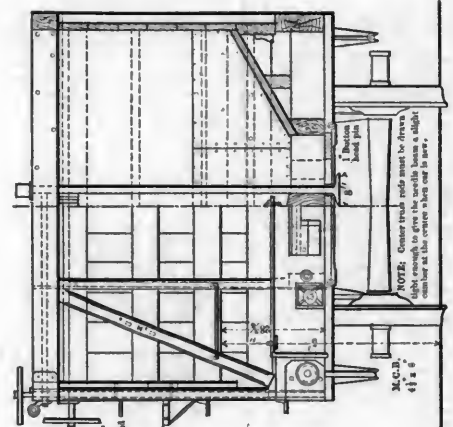
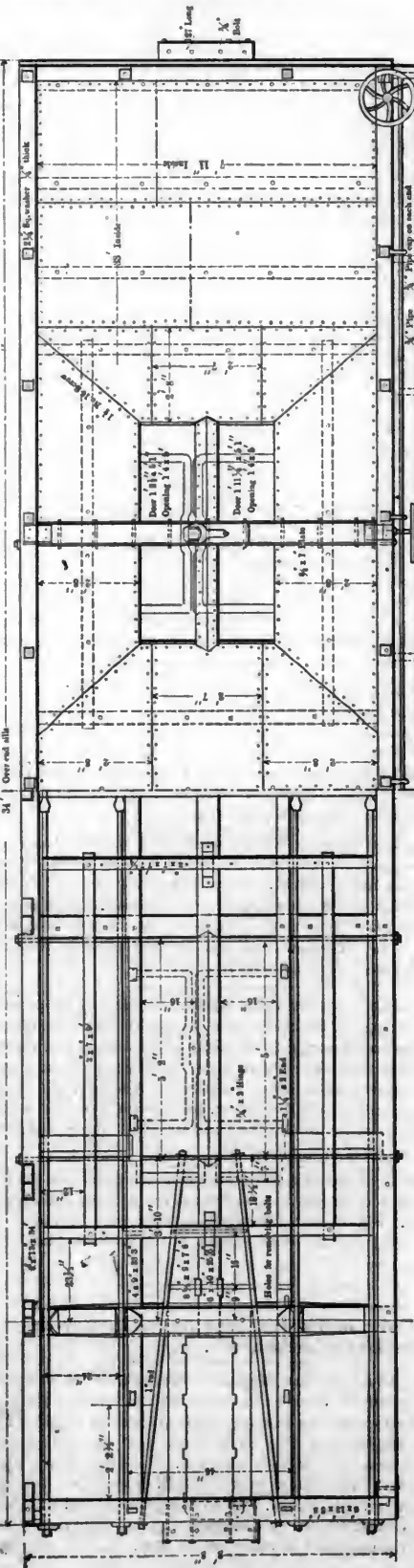
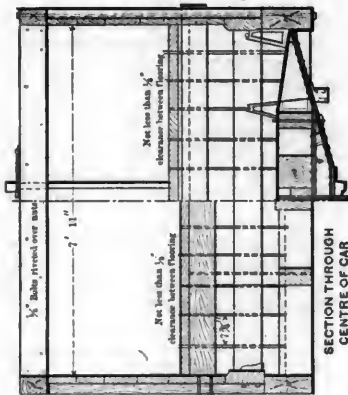
I saw recently a rather ponderous explanation in some railroad paper as to why piston rods of Laird crossheads break so often. The explanation was that it was due to the center of gravity of the crosshead being so far above the piston-rod, thus forming in action an overhanging and unbalanced weight that tends to bend the piston rod. The real cause is that the thrust of the piston acting on the short lever of the crosshead tends to rock it and force apart the guides. The wear is more rapid than with the four-bar guide because of this tendency to rock the crosshead, and therefore it is simply a question of increasing the wearing surface. Why are such self-evident facts neglected by a technical paper?

It is clear to any one who will examine the matter that the whole trouble is due to a want of wearing surface on the crosshead to resist the action mentioned. This constant effort to separate the guides wears the crosshead wings rapidly and the unbalanced overhang of the crosshead alone would not bend the rod in a hundred years. Laird guides are often convenient if not necessary in certain cases, and should be designed with the distance between guides and piston rod as short as possible and with an increase of guide surface.

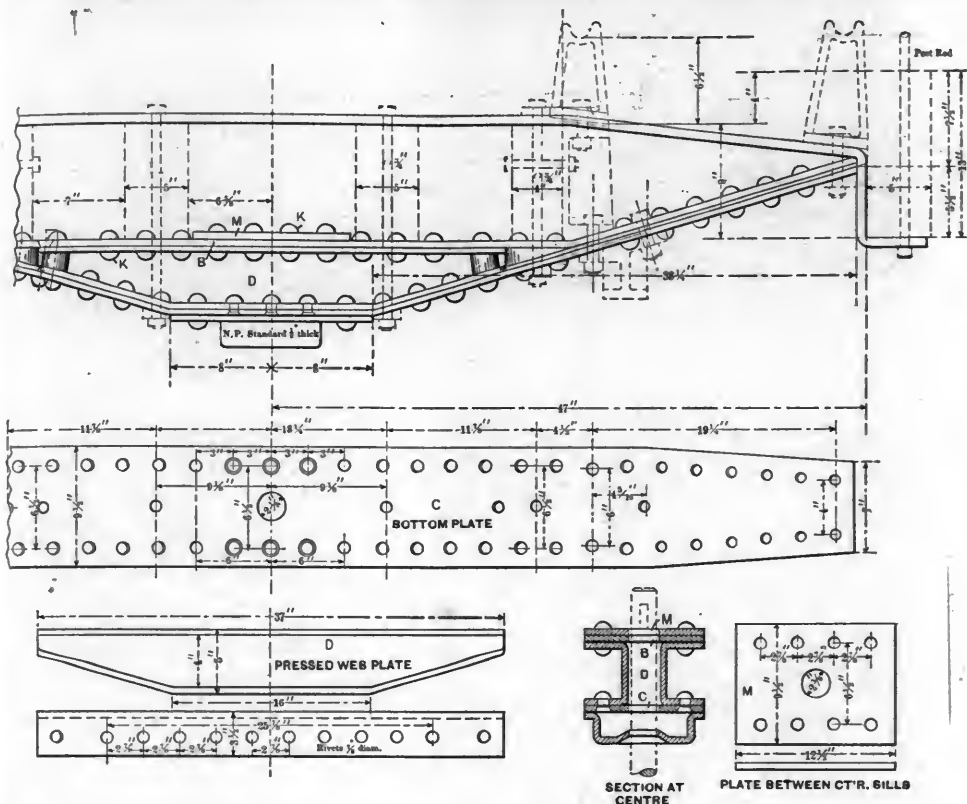
The erroneous explanation of the technical paper mentioned has, I find, been accepted by some master mechanics, who by lightening the crosshead have attempted to correct a fault which does not exist, and in more than one case ended in broken crossheads and wrecked cylinders.

G. A. HARWOOD.

[Our correspondent is apparently quite sure of his position, but he has fallen into the error of greatly underrating other people's thinking apparatus. Many close students and practical men whose opinions are respected have at various times in the last five years charged the frequent breakages of piston rods attached to Laird crossheads to the inertia of the unsymmetrical weight of the latter. Their arguments have been presented so many times that there is no occasion for us to repeat them now. The argument of our correspondent lacks clearness and force and is hardly strong enough to support his position.—Ed.]



Twin-Hopper Gondola Car of 70,000 Pounds Capacity—Northern Pacific Railroad.



Body Bolster for Gondola Car of 70,000 Pounds Capacity.

Twin-Hopper Gondola Car of 70,000 Pounds Capacity—Northern Pacific Railroad.

Several roads have built coal, ore, or other special cars to carry 70,000 pounds, but we believe that the Northern Pacific Railroad is the first to get out drawings for standard box, flat, and gondola cars of this capacity. Their box car is 41 feet long inside, 42 feet long outside of the end sills, 9 feet 1 inch wide over the sills, 8 feet 6 inches wide inside, and 7 feet 10 inches high in the clear. The flat car is 41 feet long, and the gondola car 34 ft. long. This last-mentioned car we illustrate through the courtesy of Mr. John Hickey, Superintendent of Motive Power.

As will be seen from our illustrations, the car has twin-hoppers, the slopes of which are such as to leave no level floor space, consequently the car can be emptied without any shoveling whatever. The sills of the car are five in number, one center sill 6 inches by 10 inches, two intermediate 4 inches by 9 inches and two side sills 5 inches by 13 inches. The center sill falls short of the end sills, extending barely through the body bolsters. From the bolsters to each end sill its place is taken by two timbers, 5 inches by 9 inches, to which the draft gear is attached. The drawbar is thus in the same horizontal plane as the sills.

The side framing is strong and evidently able to carry a large part of the entire load. The plate at the top of the sides is 4 1/2 inches by 7 inches and the posts and braces are heavy. The bottom side plank is 3 inches by 10 inches and the others 1 1/2 inches by 8 inches. The sides are 5 feet 5 inches high above the tops of the sills and 6 feet 6 inches high from the bottom of the latter. In addition to this framing there are two truss rods of deep camber 1 1/2 inches in diameter with ends upset to 1 1/2 inches. The needle beams are 6-inch channels weighing 12 pounds per foot.

The framing around the hoppers is clearly shown on our engravings. The hopper door openings are 5 feet long and 1 foot 4 inches wide on each side of the center sill. The doors are of unequal width so as to bring their edges to one side of the sill. They are raised into place by chains that wind up on to a shaft under a timber extending across the car and secured to the tops of the sides. The hand wheel at the side of the car is for operating this shaft. The doors are locked in position by a rod suspended from the cross-timber just mentioned and having a large T-shaped head at the lower end. This head is inserted in a slot between the doors and the rod given a quarter-turn, after which it is held from further turning by a latch that drops over its upper end which has a square on it for that purpose. The construction is shown in the plan and elevation of the car.

The bolster is of metal and very strong. The same design is employed for all of the three classes of 70,000-pound cars mentioned in the early part of this article. It consists of a top plate 7 inches by 1/2 inch in section, and two plates in compression, each of which is 9 1/2 inches by 1/2 inch in section at the center, but beginning outside of the intermediate sills are gradually narrowed to 7 inches at the ends. Between the ends of these plates there are filling pieces 1/2 inch thick, three inches wide and 34 1/2 inches long, and at the middle they are separated by two pressed steel pieces of

channel section 5 inches deep and 37 inches long. This makes a very substantial bolster, and one that if carefully fitted at the ends should be very stiff.

The center plates are pressed steel, and the Fox pressed steel truck is used under all of these cars. The body of this car weighs about 18,000 pounds, and the trucks about 12,000 pounds, making the total weight 30,000 pounds.

Motor Trucks and Motors for the Lake Street Elevated Railway, Chicago.

The Lake Street Elevated Railroad, in Chicago, is at present preparing its tracks for the change from steam to electric traction, and has ordered a total of 60 motor trucks from three different manufacturers. The McGuire Manufacturing Company, of Chicago, will furnish 50 of these; the Baldwin Locomotive Works eight, and the J. G. Brill

Company, of Philadelphia, two trucks. The motors are to be furnished by the General Electric Company, and of the class known as "G. E. 2,000."

The cars under which the trucks will be put, are of the usual size for elevated railway traffic, being about 39 feet long over the bodies, and 46 feet long over the platforms. When fully loaded the weight above the trucks will be about 38,000 pounds, and each motor weighs about 4,200 pounds. The weight of the trucks varies somewhat with the different designs.

We present to our readers engravings made from photographs of the trucks built by the McGuire and Brill companies. The McGuire truck shown in Fig. 1 is a substantial looking piece of mechanism. It is provided with double equalizing bars cushioned at the boxes to which are secured two crossbars or transoms.

The motors are supported at the axles and also by attachments to these transoms. The springs over the journal boxes have only one inch motion after receiving their normal load. The parts mentioned maintain a constant relation to each other and are independent of the spring arrangement for the car body.

The arrangement of parts supporting the car body is peculiar. The side frames, which are of malleable iron, contain pedestals for the journal boxes in which the latter are so fitted as to permit 1 1/2 inch lateral motion each way. Each frame rests on coil springs on the equalizers and has a large bracket or shelf on the inner side to receive the end of the truck bolster. Under this shelf is a double elliptic spring supported by a spring plank suspended from the transoms by swing links. The two side frames and bolster may therefore be considered a unit resting on four coil and two double elliptic springs and having a swing motion of 1 1/2 inches each side of its normal position. The great advantage of this arrangement lies in the fact that the load is hauled by the truck through the medium of side frames and bolster which are rigidly connected together.

The brakes are located inside the wheels, making a short, compact truck, occupying the least possible space under the car and making the truck frame less liable to damage in case of accident. There is no brakebeam, the brakes on one side being independent of those on the other side of the truck, but having the pull rods leading from the upper ends of the levers perfectly equalized. The brakes are suspended from the truck frame by patent elastic brake hangers, which form brake heads, brake hangers and adjustable release springs all in one, and at the same time take up their own lost motion; preventing all chattering and kicking of the brakes which is so common a fault of swinging brake hangers.

These trucks are quite similar to those furnished by the same company for the motor cars that are being tried on the Brooklyn Bridge.

The truck of the Brill Company is shown in Fig. 2. The side frame is cast in one piece, and the oil-boxes have extensions cast on their under sides, into which the ends of the equalizer bars are inserted. These equalizers are perfectly straight bars, and are partly hidden in our illustra-



Fig. 1.—Motor Truck Built by McGuire Manufacturing Company for Lake Street Elevated Railway.



Fig. 2.—Motor Truck Built by J. G. Brill Company for Lake Street Elevated Railway.

Communications.

The Westinghouse Air-Brake Company versus The Boyden Brake Company.

Editor American Engineer, Car Builder and Railroad Journal:

The issue by the Boyden Brake Company of a circular dated December 31, 1895, in which that company asserts, among other misleading statements, that the decision of the Fourth Circuit Court of Appeals in favor of that company is final, makes it necessary for us to state that the United States Supreme Court has, upon petition of our counsel, based upon a few of the serious errors involved in that decision, granted a writ of certiorari directing the case to be sent up to it for revision and final judgment.

The Boyden Company's statement was manifestly prepared before the Supreme Court granted the writ of certiorari, and it will thus be seen that that company is not yet finally authorized to make and sell quick-action air-brake, without liability for infringement of our patent rights.

We have never doubted that the final decision in this case will reaffirm the validity of our pioneer quick-action air-brake patent (No. 330,070, the one in dispute), as already established in other courts; for Judge Hughes, in his decision in favor of the Boyden Brake Company, says:

"That this invention of Westinghouse, thus undefined (the Court then referring to the second claim), is one of the highest value to the public, and that it is a pioneer one in the art of quick action brakes is not denied, and is conceded. It is conspicuously one of those pioneer inventions which entitle the proprietor to a liberal protection from the courts in construing the claim."

A statement in accord with the opinions of the other courts which have, in each instance, conceded and affirmed the pioneer-ship and value of this invention.

In each of the three previous decisions in favor of this patent, the second claim has been upheld and has not, in any manner, been held to be insufficient, even in any technical sense, to fully cover the invention; and we therefore the more strongly feel that our confidence in the ultimate determination of this litigation in our favor is well founded.

The Boyden Brake Company has issued an illustration and description of a new form of quick action triple valve, which it states was subjected to a satisfactory rack test at Altoona, by the air brake committee of the Master Car Builders' Association. This new valve has not hitherto been the subject of litigation under our patents and has never, to our knowledge, been commercially used or tested. We believe that the construction of this valve comes clearly within the claims of one of our patents, and we have promptly brought suit against the Boyden Company, to restrain that company from making and selling this new valve.

It will not be out of place to call attention to the fact that railway companies have, in numerous instances, been misled by the statements of various parties manufacturing brakes, in infringement of our rights, and the loss inflicted upon those who have purchased brake apparatus in reliance upon those statements has already been very great. We feel convinced that we are fully justified in believing that our patents fully cover all of the forms of quick action brakes which have so far been offered for sale, and that the courts will finally so decide.

THE WESTINGHOUSE AIR-BRAKE COMPANY.

H. H. WESTINGHOUSE, General Manager.

Pittsburgh, Pa., Feb. 1, 1896.

Laird Crossheads.

Editor American Engineer, Car Builder and Railroad Journal:

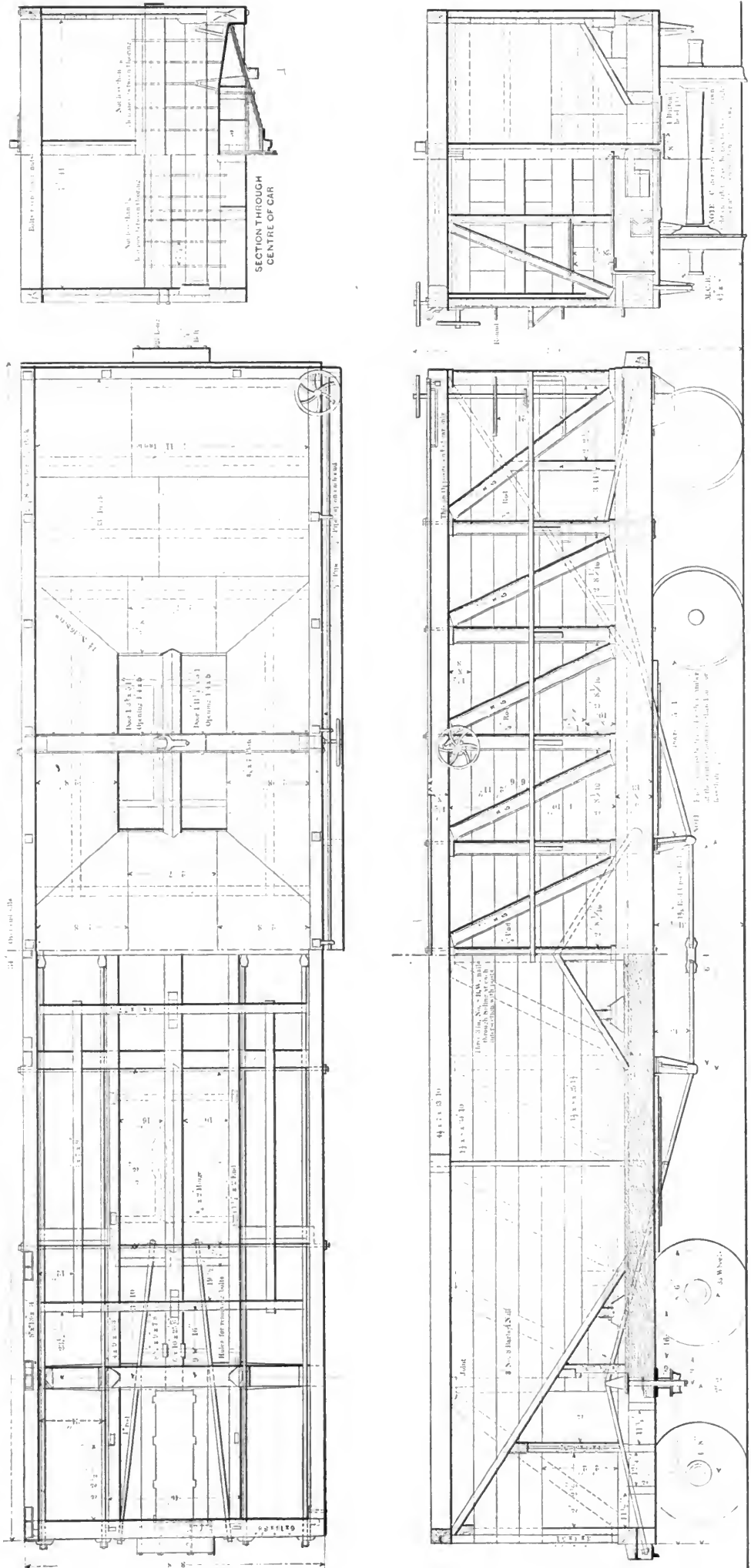
I saw recently a rather ponderous explanation in some railroad paper as to why piston rods of Laird crossheads break so often. The explanation was that it was due to the center of gravity of the crosshead being so far above the piston rod, thus forming in action an overhanging and unbalanced weight that tends to bend the piston rod. The real cause is that the thrust of the piston acting on the short lever of the crosshead tends to rock it and force apart the guides. The wear is more rapid than with the four-bar guide because of this tendency to rock the crosshead, and therefore it is simply a question of increasing the wearing surface. Why are such self-evident facts neglected by a technical paper?

It is clear to any one who will examine the matter, that the whole trouble is due to a want of wearing surface on the crosshead to resist the action mentioned. This constant effort to separate the guides wears the crosshead wings rapidly and the unbalanced overhang of the crosshead alone would not bend the rod in a hundred years. Laird guides are often convenient if not necessary in certain cases, and should be designed with the distance between guides and piston rod as short as possible and with an increase of guide surface.

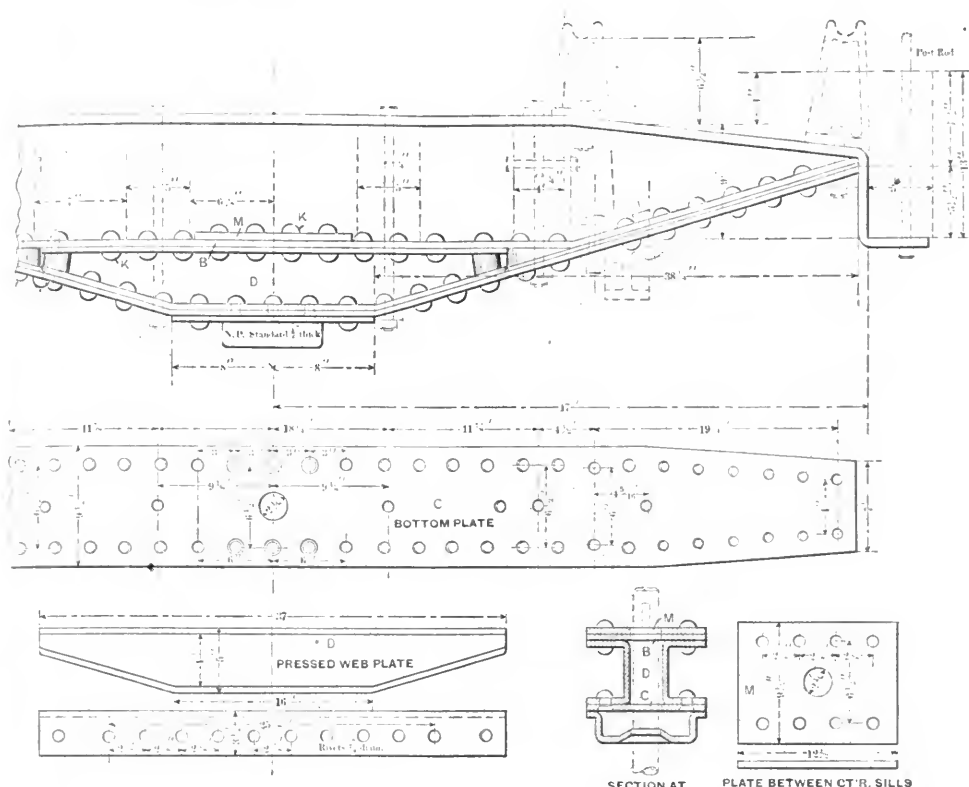
The erroneous explanation of the technical paper mentioned has, I find, been accepted by some master mechanics, who by lightening the crosshead have attempted to correct a fault which does not exist, and in more than one case ended in broken crossheads and wrecked cylinders.

G. A. HARWOOD.

[Our correspondent is apparently quite sure of his position, but he has fallen into the error of greatly underrating other people's thinking apparatus. Many close students and practical men whose opinions are respected have at various times in the last five years charged the frequent breakages of piston rods attached to Laird crossheads to the inertia of the unsymmetrical weight of the latter. Their arguments have been presented so many times that there is no occasion for us to repeat them now. The argument of our correspondent lacks clearness and force and is hardly strong enough to support his position.—Ed.]



Twin-Hopper Gondola Car of 70,000 Pounds Capacity—Northern Pacific Railroad.



Body Bolster for Gondola Car of 70,000 Pounds Capacity.

Twin-Hopper Gondola Car of 70,000 Pounds' Capacity—Northern Pacific Railroad.

Several roads have built coal, ore, or other special cars to carry 70,000 pounds, but we believe that the Northern Pacific Railroad is the first to get out drawings for standard box, flat, and gondola cars of this capacity. Their box car is 41 feet long inside, 42 feet long outside of the end sills, 9 feet 1 inch wide over the sills, 8 feet 6 inches wide inside, and 7 feet 10 inches high in the clear. The flat car is 41 feet long, and the gondola car 34 ft. long. This last-mentioned car we illustrate through the courtesy of Mr. John Hickey, Superintendent of Motive Power.

As will be seen from our illustrations, the car has twin-hoppers, the slopes of which are such as to leave no level floor space, consequently the car can be emptied without any shoveling whatever. The sills of the car are five in number, one center sill 6 inches by 10 inches, two intermediate 4 inches by 9 inches and two side sills 5 inches by 13 inches. The center sill falls short of the end sills, extending barely through the body bolsters. From the bolsters to each end sill its place is taken by two timbers, 5 inches by 9 inches, to which the draft gear is attached. The drawbar is thus in the same horizontal plane as the sills.

The side framing is strong and evidently able to carry a large part of the entire load. The plate at the top of the sides is 4 1/2 inches by 7 inches and the posts and braces are heavy. The bottom side plank is 3 inches by 10 inches and the others 1 1/2 inches by 8 inches. The sides are 5 feet 5 inches high above the tops of the sills and 6 feet 6 inches high from the bottom of the latter. In addition to this framing there are two truss rods of deep camber 1 1/2 inches in diameter with ends upset to 1 1/2 inches. The needle beams are 6-inch channels weighing 12 pounds per foot.

The framing around the hoppers is clearly shown on our engravings. The hopper door openings are 3 feet long and 1 foot 4 inches wide on each side of the center sill. The doors are of unequal width so as to bring their edges to one side of the sill. They are raised into place by chains that wind up on to a shaft under a timber extending across the car and secured to the tops of the sides. The hand wheel at the side of the car is for operating this shaft. The doors are locked in position by a rod suspended from the cross-timber just mentioned and having a large T-shaped head at the lower end. This head is inserted in a slot between the doors and the rod given a quarter-turn, after which it is held from further turning by a latch that drops over its upper end which has a square on it for that purpose. The construction is shown in the plan and elevation of the car.

The bolster is of metal and very strong. The same design is employed for all of the three classes of 70,000-pound cars mentioned in the early part of this article. It consists of a top plate 7 inches by 3/4 inch in section, and two plates in compression, each of which is 9 1/4 inches by 1/2 inch in section at the center, but beginning outside of the intermediate sills are gradually narrowed to 7 inches at the ends. Between the ends of these plates there are filling pieces 1/2 inch thick, three inches wide and 34 1/2 inches long, and at the middle they are separated by two pressed steel pieces of

channel section 5 inches deep and 37 inches long. This makes a very substantial bolster, and one that if carefully fitted at the ends should be very stiff.

The center plates are pressed steel, and the Fox pressed steel truck is used under all of these cars. The body of this car weighs about 18,000 pounds, and the trucks about 12,000 pounds, making the total weight 30,000 pounds.

Motor Trucks and Motors for the Lake Street Elevated Railway, Chicago.

The Lake Street Elevated Railway, in Chicago, is at present preparing its tracks for the change from steam to electric traction, and has ordered a total of 60 motor trucks from three different manufacturers. The McGuire Manufacturing Company, of Chicago, will furnish 50 of these: the Baldwin Locomotive Works eight, and the J. G. Brill

Company, of Philadelphia, two trucks. The motors are to be furnished by the General Electric Company, and of the class known as "G. E. 2,000."

The cars under which the trucks will be put, are of the usual size for elevated railway traffic, being about 39 feet long over the bodies, and 46 feet long over the platforms. When fully loaded the weight above the trucks will be about 38,000 pounds, and each motor weighs about 4,200 pounds. The weight of the trucks varies somewhat with the different designs.

We present to our readers engravings made from photographs of the trucks built by the McGuire and Brill companies. The McGuire truck shown in Fig. 1 is a substantial looking piece of mechanism. It is provided with double equalizing bars cushioned at the boxes to which are secured two crossbars or transoms.

The motors are supported at the axles and also by attachments to these transoms. The springs over the journal boxes have only one inch motion after receiving their normal load. The parts mentioned maintain a constant relation to each other and are independent of the spring arrangement for the car body.

The arrangement of parts supporting the car body is peculiar. The side frames, which are of malleable iron, contain pedestals for the journal boxes in which the latter are so fitted as to permit 1 1/2 inch lateral motion each way. Each frame rests on coil springs on the equalizers and has a large bracket or shelf on the inner side to receive the end of the truck bolster. Under this shelf is a double elliptic spring supported by a spring plank suspended from the transoms by swing links. The two side frames and bolster may therefore be considered a unit resting on four coil and two double elliptic springs and having a swing motion of 1 1/2 inches each side of its normal position. The great advantage of this arrangement lies in the fact that the load is hauled by the truck through the medium of side frames and bolster which are rigidly connected together.

The brakes are located inside the wheels, making a short, compact truck, occupying the least possible space under the car and making the truck frame less liable to damage in case of accident. There is no brakebeam, the brakes on one side being independent of those on the other side of the truck, but having the pull rods leading from the upper ends of the levers perfectly equalized. The brakes are suspended from the truck frame by patent elastic brake hangers, which form brake heads, brake hangers and adjustable release springs all in one, and at the same time take up their own lost motion, preventing all chattering and kicking of the brakes which is so common a fault of swinging brake hangers.

These trucks are quite similar to those furnished by the same company for the motor cars that are being tried on the Brooklyn Bridge.

The truck of the Brill Company is shown in Fig. 2. The side frame is cast in one piece, and the oil-boxes have extensions cast on their under sides, into which the ends of the equalizer bars are inserted. These equalizers are perfectly straight bars, and are partly hidden in our illustration.

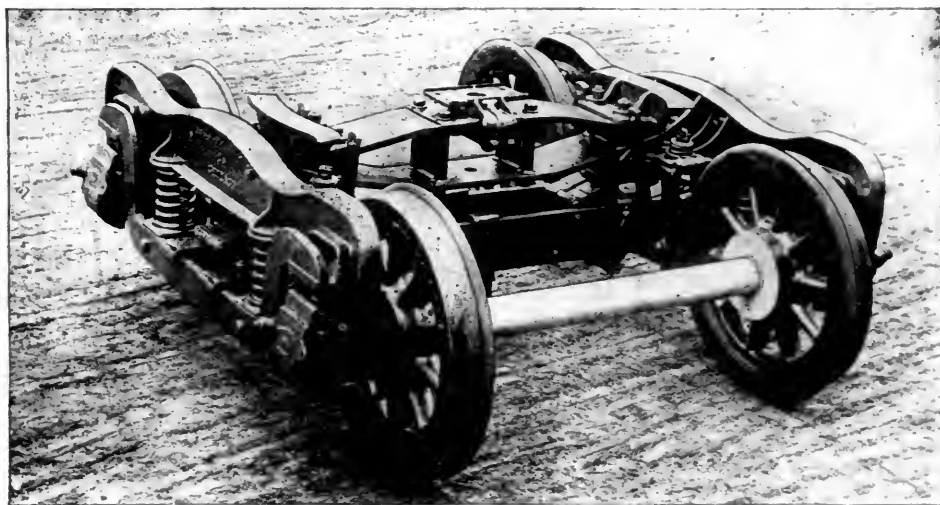


Fig. 1.—Motor Truck Built by McGuire Manufacturing Company for Lake Street Elevated Railway.



Fig. 2.—Motor Truck Built by J. G. Brill Company for Lake Street Elevated Railway.

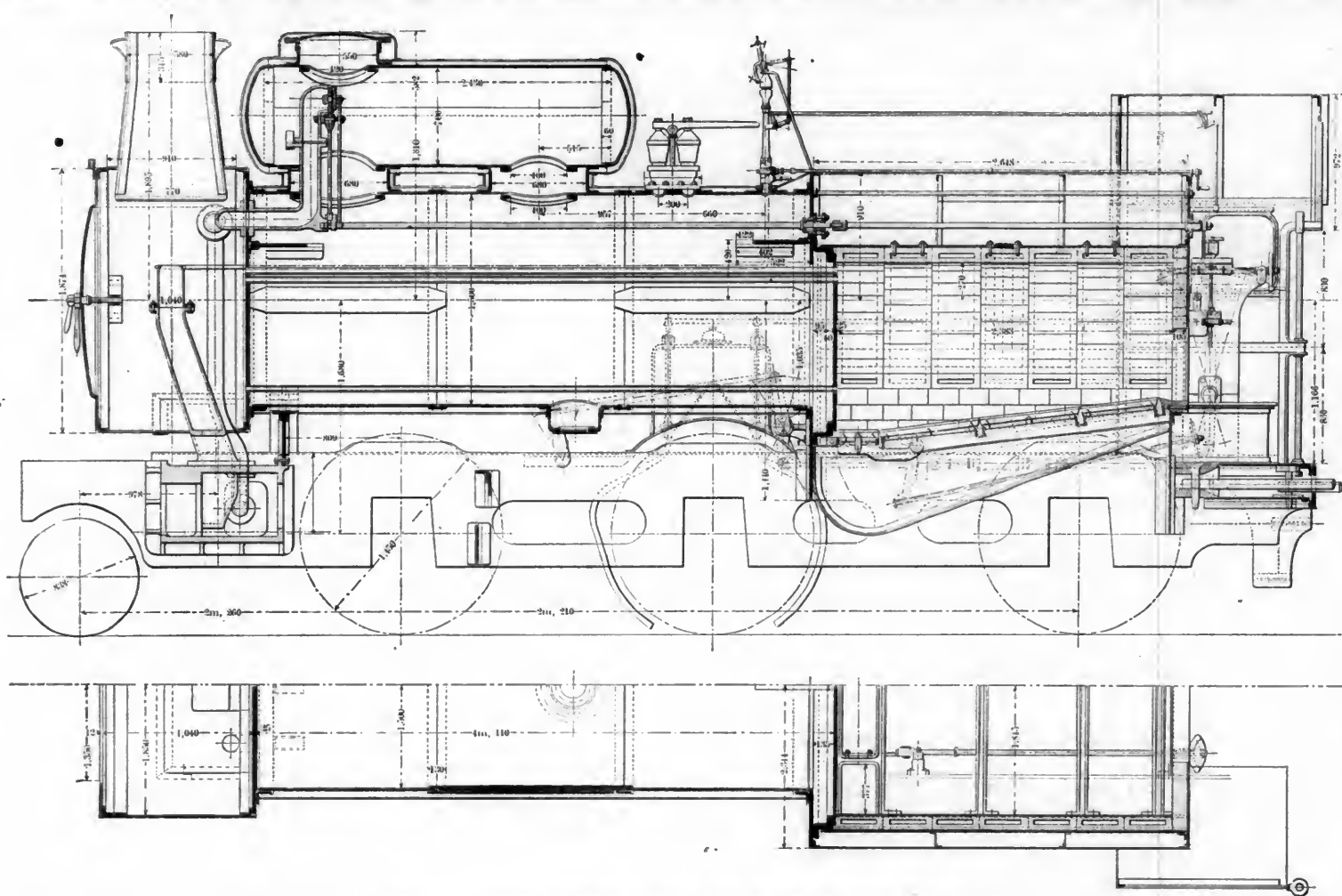


Fig. 1.—Locomotive with Firebox Lined with Firebrick.—Docteur System.

tion by the bottom bar of the side frame. The coil-springs rest on them, and, by the special construction employed, are placed nearer the journal boxes than is possible ordinarily, and thus prevent much of the tilting of trucks from the application of the brakes. The usual transoms, spring planks, elliptic springs and swing bolster complete the truck. The brakes are outside hung. The construction is exceedingly simple.

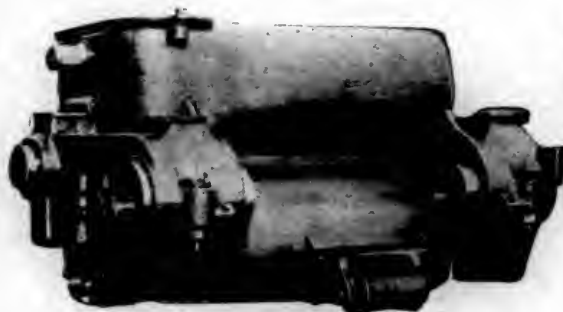


Fig. 3.—Motor "Q. E. 2000" for Lake Street Elevated Railway.

The wheels for all of these trucks are 33 inches in diameter outside of the tires, with cast-iron spoke centers and Krupp tires secured by retaining rings. They weigh about 800 pounds each. The axles have 4½ by 8-inch collarless journals. The wheel base is 5 feet 6 inches.

The motors, which we have already stated are known as "G. E. 2,000," occupy a space 53 inches wide, 33 inches high and 25 inches from the axle to the end of the motor. There are two of them on each truck, and they are geared so as to develop a speed of 40 miles per hour.

A general view of one of them is given in Fig. 3. It is designed for a drawbar pull of 2,000 pounds when mounted on 33-inch wheels. For its power, its weight is comparatively light. The armature is of the "barrel" type, a method of construction which allows of the ready repair of a damaged conductor. The iron-clad construction of the armature, so conspicuously successful in other motors by the company, is followed in the G. E. 2,000.

The design and installation of the electrical equipment of this road is in charge of General Superintendent Hedley and Chief Engineer C. V. Weston.

Harper's Weekly of February 29 contained an interesting and fully illustrated article on "How Long and Lofty Bridges are Built." Some of the great engineering triumphs in this direction were described.

Note Upon Fireboxes With Firebrick Walls.*

DOCTEUR SYSTEM.

It does not seem to me to be out of place to briefly review the history of the construction of locomotive boilers, intended to accomplish the object which I have had in view for a number of years, when I proposed to the management of the State Railways of Belgium to make a test of a firebrick furnace and of building a trial boiler on my system.

The first locomotives hauling passenger and freight trains on the Manchester & Liverpool line (1836 to 1838) had iron fireboxes, and were fired with coke. These fireboxes were built of the materials procurable at the time, that is of high-grade materials, of whose actual quality we have no idea. Nevertheless, the shop superintendent of the line met so many difficulties in the maintenance of the engines and the running was so irregular that he proposed to Stephenson to substitute red copper for iron in the fireboxes, the sheets of copper being likely to last indefinitely, and then, after they

to say, from 18 to 20 degrees Beaumé. With coal the use of copper tubes has been resumed, and tubes of this kind are now being tested on the State Railway of Belgium, and they appear to be giving satisfactory results.

Likewise smokebox tube-sheets of copper are behaving very well in service.

But the high price of these materials adds very considerably to the cost of the boilers, and this, together with the value of the sheets held in stock for repairs, locks up a good deal of capital.

It was in order to avoid this increased expense that I have attempted to design a locomotive boiler at the lowest possible cost, while still retaining the copper tube-sheet in the firebox which the use of our ordinary fuels imposes upon us, and of forming the sidewalls and back of the firebox of refractory material which has been shown to have such a favorable influence upon combustion.

I did fear a loss resulting from the almost total suppression of the direct heating surface and the consequent

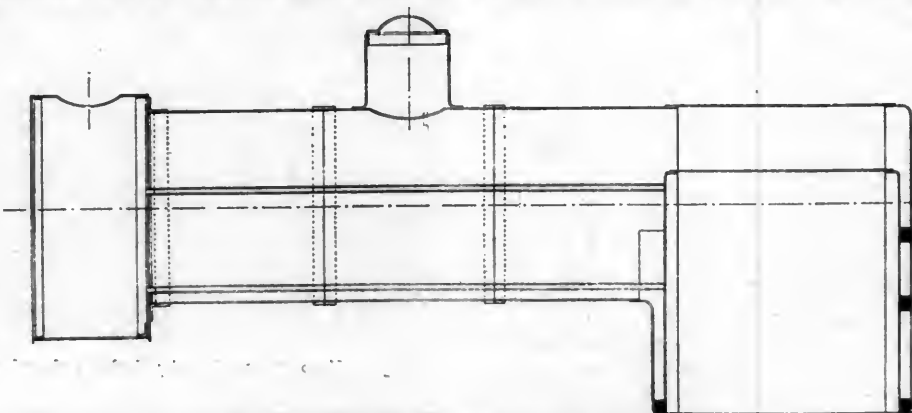


Fig. 2.—Original Boiler in Experimental Locomotive.

had been removed from service, still having considerable value.

So the iron fireboxes were replaced by those of copper, and it is only under exceptional conditions that we have reverted to the former.

The red copper tubes that were in use at the same time were abandoned and brass substituted in their place, because the copper was so rapidly scored by the coke. As a general thing, the life of the copper tubes ranged from six to eight months, while those of brass could be kept in service from two to three years.

Afterward charcoal and homogeneous iron tubes were used where the feed water was comparatively pure; that is

reduction of the evaporating surface, the latter not even retaining the crown-sheet. Experience has shown that my apprehensions on this second point were entirely without foundation.

To compensate for this partial suppression of the direct heating surface, I increased the diameter of the shell so as to be able to increase the number of tubes used, the boiler built after my plans having 336 tubes.

I was thus sure of having an excess of heating surface and of being able, without injuring the regularity of the service to be rendered by the locomotive, to plug a certain number of the tubes in order to determine whether the direct heating surface has the important influence that has been attributed to it up to the present time.

In order to compensate for the loss of steam space resulting from the removal of the shell from over the firebox, I

* From a paper by M. Docteur published in the *Revue Universelle des Mines*.

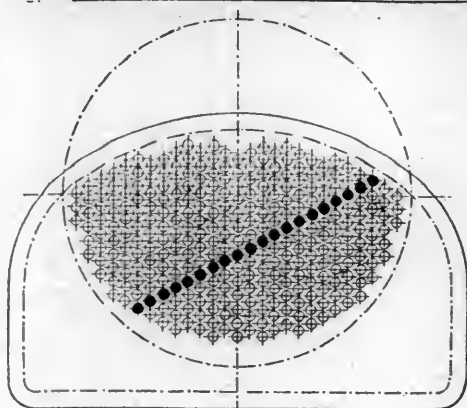


Fig. 3.

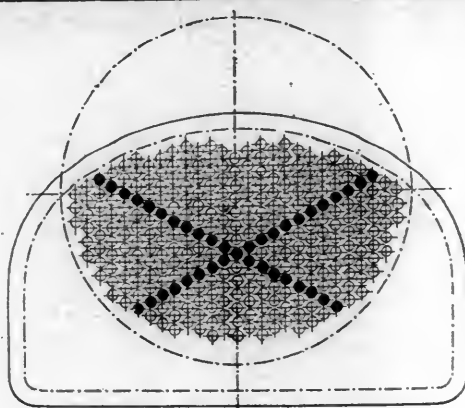


Fig. 4.

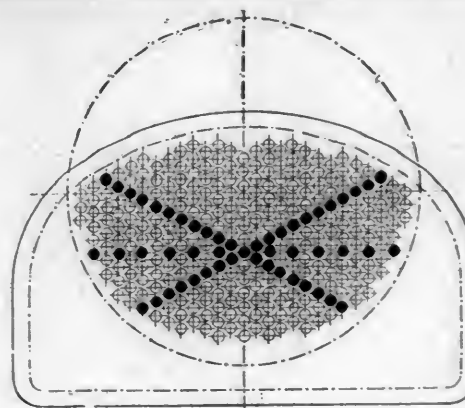


Fig. 5.

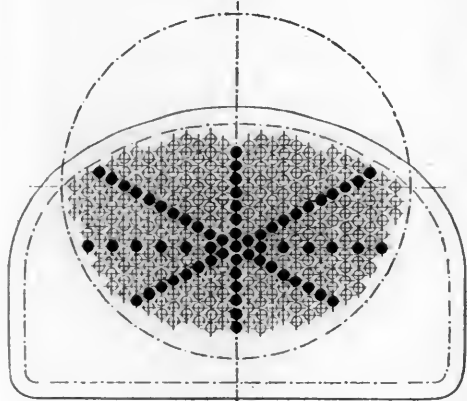


Fig. 6.

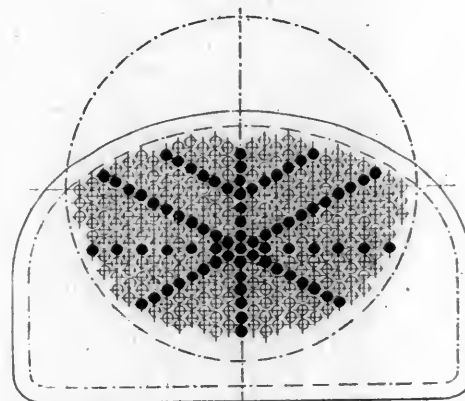


Fig. 7.

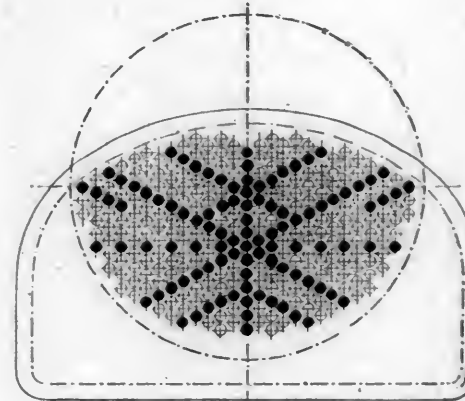


Fig. 8.

Diagrams Showing Tubes Plugged in Experiments on Amount of Tube Heating Surface Required with Firebrick Firebox.

have put a steam drum on the boiler at the front end. The cubic contents of this drum are about 24½ cubic feet more than the steam space of ordinary boilers, including that of the shell, above the crown sheet and the dome.

The supplementary drum is provided with manholes through which the boiler can be entered, and by which the throttle and dry pipe are rendered accessible. Fig. 1 shows the arrangement and appearance of a locomotive fitted with this new boiler.

It was important to definitely ascertain whether a wall of firebrick could be maintained in the firebox of a locomotive, to note the durability of such a wall in service and to make sure of the circulation of air about the bricks, as much for the purpose of keeping them cool as to make a delivery of hot air above the grates.

Results obtained prove that it is sufficient to increase the indirect heating surface by an amount equivalent to the direct heating surface suppressed in order to obtain a production of steam at least equal to that obtained under the original conditions; in fact, when the heating surface was reduced to that of the old boiler by the plugging of the tubes, there was no change in the regularity of the working of the engine. Therefore one square foot of direct heating surface has no more influence in the production of steam than the same amount in the tubes.

The tests of the new firebox with firebrick walls were made on locomotive No. 512, with outside cylinders and having the following principal dimensions:

Diameter of cylinder.....19.1 in.
Stroke of pistons.....36 in.
Steam pressure per square inch.....142 lbs.
Diameter of driving wheels.....4 ft. 11½ in.

Figures 1 and 2 show the outline of the old and new boilers.

The locomotive fitted with this new firebox was sent out from the Luttre shops on Feb. 20, 1894. From that time it has hauled trains Nos. 4,573, 3,574, 4,805, 3,331, 3,330, 4,163, 4,164 on the line running from Luttre to Brussels and Antwerp and back by way of Braine-le-Comte and also the trains running between Luttre and Tournai.

Care has been taken to keep an account of the production of steam in the new boiler; the consumption of coal by the engine, as well as the life and strength of the firebrick. Locomotive No. 512, coupled to the trains cited above, has hauled the load of a freight locomotive and the boiler has always furnished steam in sufficient quantities to insure the running of the trains without stalling or delays.

The results of the different tests to which it has been subjected show that the new boiler gives very satisfactory results when taken from the standpoint of the evaporation of water and that this evaporation sometimes amounts to from 8½ to 9 pounds of water per pound of coal burned when hauling through trains with a light load:

The combustion of coal in the firebox is perfect; this is due, in the first place, to the high temperature which is maintained in the firebox, whose walls are not constantly cooled by contact with water, as in the firebox of ordinary boilers; and, secondly, to the fact that the hot air which is admitted above the bed of coal that is burning upon the grate suffices to burn all the gases arising therefrom.

Furthermore, there are never any black spots upon the grates; when the coal is thrown in it is at once raised to such a temperature that it becomes incandescent immediately, and its gases are not distilled from it, as in the case of other fireboxes.

The temperature of the gases on entering the smokebox

never exceeds 750 degrees Fahrenheit at a few inches from the tube sheet, as in the best freight locomotives.

There are fewer cinders in the smokebox than in the ordinary boilers; they are much finer and comparatively cooler.

The production of carbonic oxide is avoided; the flames developed in the firebox are always clear and evenly distributed over the whole surface; the production of heat in the

firebox is very great and still the loss of heat due to radiation should be small on account of the firebrick sides, which have a thickness of 3.94 inches, besides a current of air passing around the bricks; also, the sheet metal covering that is outside the bricks has a lower temperature than that covering the ordinary firebox; it is possible, without any danger of being burned, to place the hand on this jacketing over the firebox of locomotive No. 512.

The admission of hot air, which circulates between the two parts and in the passages of the double wall, forms a perfect smoke preventative regardless of the quality of the coal used. For example, the new firebox has been fed successively with Fleny coal for furnace use, forge coal, pure semi-bituminous coals and a mixture of semi-bituminous and fine coal and in every test it was almost impossible to distinguish any difference in the haze of smoke issuing from the stack while the train was in motion.

The new firebox was fed with a mixture of three-quarters of fine coal and one-quarter of coking coal, and under these conditions 8 pounds of water was evaporated per pound of coal (see table 1.); 8½ to 9 pounds of water have also been evaporated per pound of coal, as we have already said; in hauling through freight, when the firebox was always at work, the evaporation has risen above 9 pounds.

The coal consumption of engine No. 512, when it had its old boiler with a small deep firebox using, on an average, the best quality of coal, has always been more than 80 pounds to the mile, while with the new boiler it dropped to 54½ pounds on a run of 11,700 miles.

There is another advantage possessed by the new firebox—the draft through the bed of coal is very much reduced by the hot air entering through the openings in the walls and when it comes into the firebox above the bed of coal, the result is that the coal is not carried into the smokebox and that it is even preferable to use lighter and finer coal.

The gases, although raised to a very high temperature in the firebox, seem to have lost much of this heat after passing through tubes 13 ft. 1½ in. long; in fact neither the smokebox nor its doors have ever been brought to a red heat by the temperature of the products of combustion.

Table No. 1, shows the trains hauled by the locomotive fitted with the new firebox, as well as the consumption of coal and water that has been observed during the experiments.

Table No. 2, gives: (1) the total amount of work done by this locomotive during the tests; (2) the total consumption of coal during the same period; (3) the allowance of coal attributed to the engine for the work which it has done.

The results given by these figures are very satisfactory, and can only be attributed to the change in the boiler; in fact, tests made in 1891 on the average working of the same locomotive with its old boiler are entirely unfavorable to its use.

All metal parts entering into the construction of the new boiler are in perfect condition up to the present time; no defects and no weakness have been detected even in the smallest pieces of the shell, and this is especially true of the firebox tube sheet, the apical ring holding this sheet, and the different portions of the drum, etc. The water gages, the throttle lever and rods, although put in front of the firebox as in other locomotives, have given no trouble in handling and have given no annoyance to the driver.

Experiments have also been made with the boiler for the purpose of determining the effect of the direct heating surface of the firebox, and how many square feet of heating

TABLE NO. 1.

Date of Test.	No. of trains hauled.	Consumption		Evaporation of water per kilo. of coal used.
		Of Water in liters.	Of Coal in kilograms.	
March 1.....	3331	1,552	650	10.00
" 3.....	4804	7,128	950	7.50
" 3.....	4873	4,697	650	7.22
" 6.....	4874	5,701	1,200	7.25
" 6.....	4873	1,389	640	7.31
" 9.....	4874	8,239	1,100	7.49
" 9.....	4873	6,160	850	7.24
" 11.....	4874	7,354	1,050	7.45
" 11.....	4873	5,282	750	8.25
" 16.....	4874	7,084	850	8.33
" 16.....	4873	4,740	675	7.00
" 20.....	4874	8,930	1,100	8.11
" 20.....	4805	3,773	475	7.90
" 21.....	3330	5,383	750	7.17
" 21.....	4873	4,515	600	7.57
" 23.....	4874	5,004	750	7.90
" 23.....	4873	5,600	750	7.46
" 27.....	4874	8,208	1,000	8.20
" 27.....	4163	9,702	1,050	9.24
" 28.....	4164	16,063	2,050	8.22
" 28.....	4873	6,008	700	8.58
" 30.....	4874	7,161	850	8.42
" 30.....	4873	4,387	600	7.30
" 30.....	4874	8,065	950	8.51
April 3.....	4805	4,881	650	7.50
" 4.....	3330	5,390	675	8.28
" 4.....	4874			
" 5.....	4845			
" 7.....	3330			
" 7.....	4805			
" 10.....	3331			
" 11.....	4873			
" 13.....	4871			
" 13.....	3331	4,312	690	
" 13.....	4804	5,390	750	

NOTE.—There were 20 tubes plugged on trips of March 23 and 27. 39 plugged on the 28th and 30th, 51 on April 3, 64 on April 4, 5 and 7, 76 on the 10th, 100 on the 11th, and outbound trip of the 13th, while on the return trip of the 13th the admission of air above the fire was cut off.

TABLE NO. II.

Time of test.	Run of the locomotive in kilometers	No. of actual units hauled.	Consumption		Total.	Allowance of fuel.	Consumption of coal per kilometer.	Per virtual unit hauled.
			Of bituminous coal.	Of fine coal.				
February.....	339	25,364	1,600	3,000	4,600	7.815		
March.....	1,462	119,888	8,600	16,400	25,000	33.444		
April.....	855	68,776	3,000	9,600	12,600	17.707		
Jusqu'au 13.								
	2,656	214,648	13,900	29,000	42,900	59.866	15.68	0.19

Saving 17,635 kilograms, or 33 per cent.

surface in the tubes should be used to replace one square foot of heating surface in the firebox. In the course of our experiments with the locomotive having the new boiler we have plugged in succession, 20, 39, 51, 67, 76, and even 100 tubes. The engravings (Figs. 3, 4, 5, 6, 7 and 8) show the tubes that were plugged.

These tests have shown that with 76 tubes plugged, the locomotive is capable of supplying sufficient steam to haul the regular train assigned to freight locomotives on the line over which it was run.

The heating surface, before the plugging of the tubes, was:

15.57 square feet in the tubes,
1,707.21 " " " firebox,
1,722.78 " " " total heating surface.

After 76 tubes had been plugged the heating surface was:

15.57 square feet in the tubes,
1,283.22 " " " firebox,
1,298.79 " " " total heating surface.

The figure is practically the same as the total heating surface of type No. 25 on the Belgian State Railway, which is 1,290.06 square feet, divided as follows:

1,176.75 square feet in the tubes,
122.31 " " " firebox.

From this we can conclude that the difference in the production of steam between the direct and indirect heating surfaces of locomotives is inappreciable. In further confirmation of this we obtain the same result by comparing the heating surface of the old boiler of locomotive 512 with the heating surface of the new boiler after 76 tubes had been plugged; in fact the heating surface of locomotive No. 512 fitted with the old boiler was 1,263.24 square feet, distributed as follows:

1163.43 square feet in the tubes,
99.81 square feet in the firebox.

It should be remembered that the production of steam in this last boiler was always insufficient for the work that it had to do.

Finally we would call attention to the last tests made with the new firebox, where the draft of air through the walls was entirely stopped; these experiments showed an instant

Construction and Maintenance of Railway Car Equipment. III.

BY OSCAR ANTZ.
(Continued from Page 22.)
DRAFT GEAR.

The draft gear of freight cars is subjected to greater strains and more abuse and has been the cause of more loss of life and of more injuries to railroad employees than perhaps any other part of railroad equipment. It is therefore but natural that it has received considerable attention and has been the subject of many experiments which have resulted in numerous inventions and designs of more or less merit. The danger attendant to the coupling of cars by the link and pin has been made manifest to the general public by the numerous accidents to railroad trainmen, resulting in loss of life or limb, and the desire to invent some kind of automatic coupler which would not necessitate going between the cars to couple and uncouple has been a favorite one with many who otherwise had but little idea of practical railroad work. Naturally, many of the resulting designs are not of practical value when put into actual service, even though there may appear to be some merit in them when in the shape of models.

The great majority of the car couplers invented have never been put into actual use, and even those that have proved successful and have been adopted or put into extended use are so numerous that it would be impossible in this article to describe them; and no attempt will be made to do it; a general description of some of the types in common use only will be given.

The draft gear can be considered as consisting of two distinct parts, viz., the coupler or drawbar, which connects the cars together, and the drawbar attachments which connect the drawbar to its own car and transmits pulling and buffing strains to the framework.

The drawbar itself can be considered as consisting also

them are putting a draft gear on all their new cars which uses the castings and sizes of iron, bolts and timbers and the general arrangement recommended, some slight variations being made in minor details to conform to the general practice of those particular roads. A description of this recommended draft gear can therefore be considered as covering quite a number, if not a majority of the draft gears in use on freight cars in this country.

Figs. 12, 13 and 14 show three views of this draft gear as attached to the frame of a car, the drawbar and rear end attachments, with exception of the follower plates being omitted. Figs. 15 and 16 show the drawbar, with the two most common styles of rear end attachments,

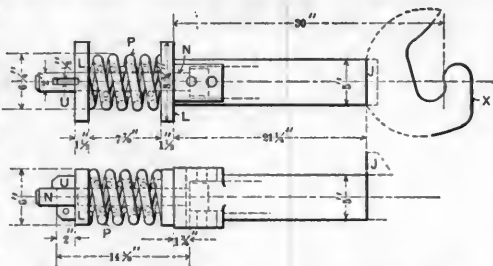


Fig. 15.—M. C. B. Standard Coupler with Tail Pin.

either of which can be used with the above draft gear without any changes. The draft timbers *AA* are of oak, 5 1/2 by 8 inches in section, and are fastened securely to the center sills by means of 1/2-inch bolts, *BB*, which have double nuts on the bottom, the heads resting in cast-iron socket plates let into the floor. When the center sills do not come directly over the draft timbers, they can be furrowed out by bolting pieces to their sides, to obtain solid timber for the bolts to pass through, and to get a good bearing for the draft timbers, as shown in dotted lines at *VV*, Fig. 14. To resist displacement and to relieve the bolts of some of the strains, cast-iron key blocks, *CC*, are inserted between sills and draft timbers, being let into each and held in place by bolts passing through them. With iron body bolsters the rear ends of the draft timbers are usually passed through between the two members, with shoulders against these, and extending about 18 inches or 2 feet beyond; stiffening pieces are then added to fill up the space between the ends of the draft timbers and the cross tie members. When wooden body bolsters are used the ends of the draft timbers are fitted against these.

The front ends of the timbers pass under the end sill and, when wooden face blocks are used, these drop down below the end sill about 1 1/2 inches and the draft timber is cut away the same amount, forming a shoulder.

The inside of each draft timber is cut away 1 inch for a certain distance, and against the shoulders thus formed, the cast-iron drawbar stops *DD* are fastened. There is quite a variety of these castings, of all shapes and sizes, and the ones shown are about as strong and heavy as any in use; they are fastened to the draft timbers by five 1/2-inch bolts the heads of which are next to the casting and are prevented from turning by ribs on the casting; the nuts rest on plate washers and are prevented from turning by pieces of hardwood nailed to the timbers, which can be easily removed in case the bolts have to be taken out. To further secure the castings, lugs, 1/2 inch square in section and 5 inches long, *EE*, are cast on the back and let into the draft timbers. Cylindrical lugs of about 1 inch in diameter are sometimes used instead, but they are broken off easily and are therefore not very reliable. There are two castings to each timber, one to take the pulling and one the buffing strains. The two castings are connected together on top and bottom by wrought iron drawbar-guides, *FF*, which transmit some of the strains from one to the other, and also act as a guide to the follower plates. They are made of 1/2 by 2 1/2-inch or 1/2 by 2-inch

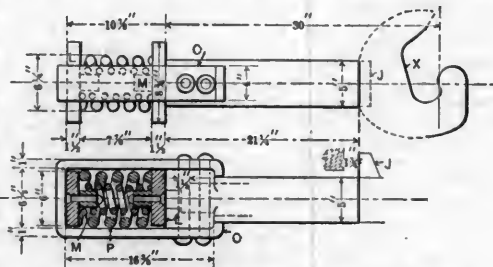
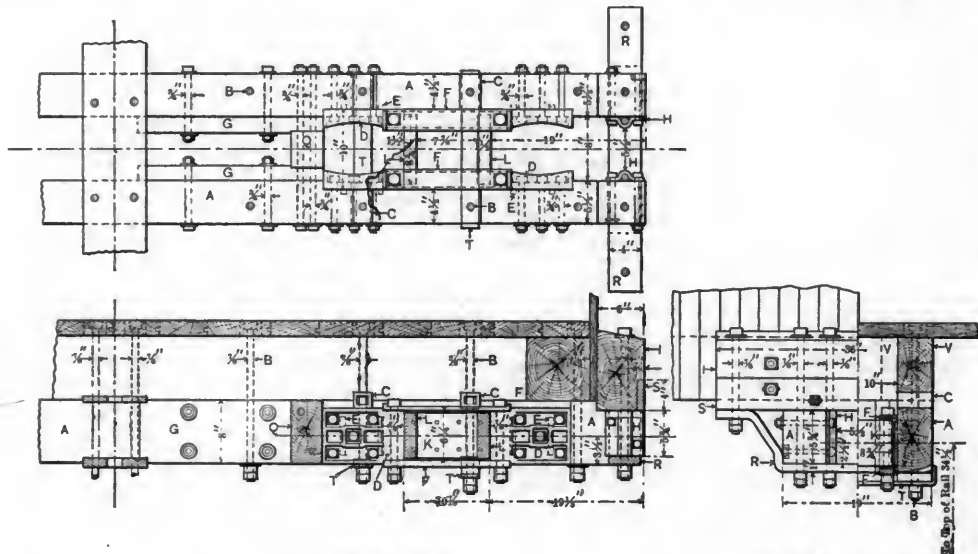


Fig. 16.—M. C. B. Standard Coupler with Strap.

iron and are fastened to the castings by 1/2-inch bolts. When no timber comes directly over these bolts the top guide is turned up at the ends to prevent the bolts from turning, the bottom ends being provided with lock nuts. When there is a timber above them the bolts are carried through this and the floor and their heads rest in cast iron sockets let into the latter.

The draft timbers are sometimes re-enforced by additional timbers, *GG*, placed between the back drawbar stop and body-bolster and tied to them by 1/2-inch bolts; these timbers take some of the buffing strains.

The two draft timbers are tied together back of the drawbar stops by two 1/2-inch bolts passing through from one



Figs. 12 and 13

Fig. 14.

Draft Gear for Freight Cars Recommended by the Master Car Builders' Association.

diminution in the production of steam, an increase in the consumption of coal, and a far less perfect combustion of the fuel in the firebox.

The use of refractory materials in the fireboxes of tubular boilers demands special care in the installation, the necessity for which was recognized at the time the boiler was fired for the first time, which was upon Dec. 15, 1893, and before all the work upon the engine, such as placing the jacketing, etc., had been completed.

It is important that the admission of cold air should be avoided to as great an extent as possible, when the bricks are heated to a white heat, and that the fire should not be hauled immediately after ending a run, but should be allowed to die out gradually.

It has been stated that in proceeding in this way the steam pressure will be maintained for several hours.

Steam has always been raised, even from cold water, in one and a half hours, while, with the ordinary boilers, it requires at least three hours.

The expansion of the shell has been measured with great accuracy by means of points on the frame, and it has not exceeded from .15 to .20 inches.

We may consider that this boiler is perfectly safe, for it consists of a cylindrical shell and tube sheets braced by the tubes as well as by re-enforcing sheets and ties. The tube sheets were found to be perfectly flat after a run of 11,025 miles.

Finally, this boiler effects a considerable saving in invested capital, as compared with the boiler of an ordinary freight locomotive having approximately the same dimensions; the saving is estimated at 5,000 francs (\$1,000) per boiler.

Expense of a complete renewal of the brickwork (materials and labor) does not exceed 100 francs (\$20) and can be done by an ordinary mason in three days.

It should be remembered that the expense of merely replacing a few staybolts in an ordinary boiler frequently exceeds this amount. Furthermore, by the use of this new type of boiler, a saving of from 10 per cent. to 12 per cent. in fuel can be made when air is admitted above the grate:

of two distinct parts, the front or coupling part, which couples with another drawbar and the rear end or shank, by which it is connected to the draft gear of its own car. The front end is independent in its design on the method of attachment at the rear end.

The M. C. B. Association has adopted as standards certain sizes and relations of parts of the drawbar, without recommending any one particular construction, the type adopted being the so-called vertical plane coupler, which does not require the use of a link and pin. Only the outline of the parts which come in contact in coupling are laid down, the details of construction being left to the individual judgment of the inventor or car builder. This contour line is shown in full lines at *XX* in Figs. 15 and 16, and some of the couplers will be described in detail in a future article.

The drawbar attachments on the frame of the car, while they vary greatly in detail, still have some general points of resemblance, and may be described as consisting of lugs or stops attached to the center sills (either direct or through the intervention of draft timbers), against which large washers or plates are placed, and to which are transmitted the pulling and buffing strains of the drawbar, springs being introduced to lessen the shocks.

Attempts have been made to have other parts besides the drawbar adopted as standards, but there is such a vast diversity of opinions, that as yet no design has been made which meets the approval of all or even a majority of the car builders. The nearest approach to uniformity which has been made is the recommendation by the M. C. B. Association of a certain design which is considered as good practice. Many roads have draft gears which approach very closely to this design, the variations being principally in the details, and while the design has not been adopted exactly as submitted by any road, some of

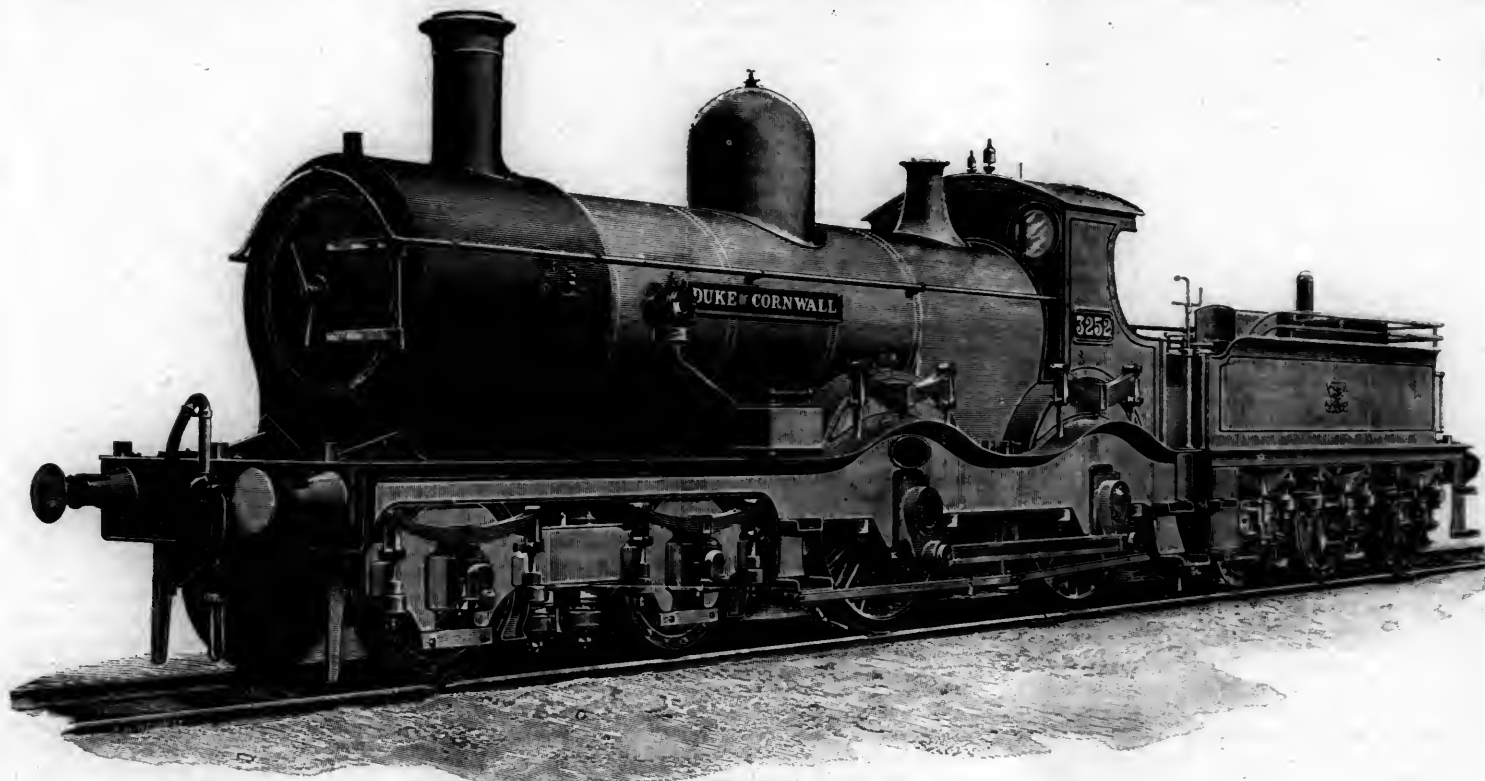
to the other, through a distance piece, *QQ*, 4 inches wide, fitted between the timbers or the re-enforcing pieces. Other ties, *TT*, of $\frac{3}{4}$ by 2 $\frac{1}{2}$ -inch wrought iron are placed under the draft timbers at or near the drawbar stops, lipped up on the ends and fastened by $\frac{3}{4}$ -inch bolts; the front one has distance pieces under it to lower it sufficiently for the follower plates to work. The front ends of the draft timbers are tied together by the drawbar carrier-iron, *RR*, of 1 by 4-inch wrought iron, which also acts as a support for the drawbar, the draft-timbers being cut out on the bottom to receive it. The ends of this iron are bent up and fastened to the under side of the face block, or, when this is not used, to the endsill. Six $\frac{3}{4}$ -inch bolts hold this iron in place, four at the center and one in each end, all having lock nuts on the bottom. The two inside bolts come between the draft timbers and close to them, and over these bolt draft timber guards, *HH*, 5 $\frac{1}{2}$ inches high and preferably made of malleable iron, are fastened, each by two $\frac{3}{4}$ -inch bolts; a

B. standard size being 6 by 8 $\frac{1}{2}$ by 1 $\frac{1}{2}$ inches, and are made of wrought iron. When a spindle is used to connect them to the drawbar, they have a 2 $\frac{1}{2}$ -inch hole through the center; with a yoke or pocket connection a hole is drilled in them, countersunk on the outside, to take a $\frac{3}{4}$ -inch rivet, which fastens a cast-iron thimble, *MM*, to hold the draft springs in place. The earlier drawbars and many in use to-day are connected to the follower plates by means of a spindle or tail pin, *NN*, as shown in Fig. 15. This pin is 2 inches in diameter, and its front end is provided with a head, either rectangular or cylindrical, with a flat space to prevent its turning; the rear end is either threaded for a nut or preferably has a slot in it to take a $\frac{3}{4}$ by 2-inch wrought-iron or steel key, *UU*, which is prevented from working out of place by a ring or cotter pin.

It was soon found that this spindle connection was not as reliable as was desired, as the head became worn, allowing the drawbar to be pulled off the pin, or the latter

unusual about it except the extension front already alluded to and the staying of the firebox crown. The front half of the crown is stayed by longitudinal bars, the front ends of which rest on the flange of the tube sheet, while the rear ends are suspended from the shell by heavy sling stays. The rear half of the crown sheet is stayed by short transverse bars of inverted \angle section, supported by sling stays to the shell. These transverse bars are only one-half the width of the box in length. This peculiar staying is employed to avoid rigidity. The boiler carries 160 pounds pressure.

The main driving axles have journals inside and outside of the wheels, but on the rear axles there are outside journals only. The driving springs are without any equalizing arrangement of any kind, and are peculiarly disposed in that while there is one spring over each rear journal there are two sets of main driver springs; one set is placed over the outside journals and the other set is under the inside boxes.



New Passenger Locomotive for the Great Western Railway of England.

rectangular opening 5 $\frac{1}{4}$ inches wide and 5 $\frac{1}{2}$ inches high is thus formed between the draft timbers in which the drawbar works. This opening has been adopted as standard by the M. C. B. Association, as has also the section of the drawbar at this point, viz., 5 by 5 inches.

The drawbar projects a certain distance beyond the end of the draft timbers, the standard adopted by the M. C. B. Association being 10 $\frac{1}{2}$ inches to the center of contact between the couplers of two cars when there is no strain on them; this would leave only 21 inches between the two cars if the draft timbers were to end at the endsill, which would hardly be sufficient to allow a person to step between the cars, and it would be still less if the draft springs were compressed. When the endsills are on the outside of the sheathing, they are generally tapered down at the ends to increase the space between the cars, but to increase it considerably for at least part of the width of the car, face blocks, *II*, are fastened to the endsills above the draft timbers, and the draft gear is carried ahead a distance equal to the thickness of this block, thus increasing the distance between the bodies of the cars by double the amount. These face blocks also strengthen the endsill at its weakest point, and as they take all the wear due to the working of the drawbar, the cost of repairs is considerably reduced, as they can be renewed much more readily than the endsill.

This face block is made of oak, usually about 36 inches long and 6 by 9 inches in section, and is securely bolted to the endsill, two of the bolts often passing back and ending in plates which lip over the body bolster. On the front bottom edge of the face block a protecting plate, *SS*, is fastened, against which the horn *JJ* of the drawbar strikes when the latter is pushed in, forming a stop for it. This plate is made of $\frac{3}{4}$ or 1 inch by 4 inches wrought iron and sometimes of angle iron. The distance between its face and the horn of the drawbar is 1 $\frac{1}{2}$ inches when there is no strain on the bar, which is another standard of the M. C. B. Association.

The inside of the draft timbers between the drawbar stops is sometimes protected by a plate of $\frac{3}{4}$ by 6 inches wrought iron, *KK*, secured by countersunk wood screws, which prevents the follower plates from chafing the timbers.

The follower plates, *LL*, are two in number, the M. C.

would break, or the key would break or work out, allowing the drawbar to drop on the track, where it formed a dangerous obstruction and has been the cause of numerous wrecks. Another objection to the spindle connection is the large hole required in the follower plates.

These objections are overcome as shown in Fig. 16 by substituting a strap of wrought iron, *OO*, bent in the shape of a U and fastened to the top and bottom of the shank of the drawbar, forming a pocket, in which the follower plates and draft spring are placed. This pocket strap, or yoke, is made of 1 by 4-inch wrought iron with an opening 6 $\frac{1}{4}$ inches wide and as long as is required for spring and follower plates, $\frac{3}{4}$ -inch being allowed for compression of the spring. The strap has hooks turned on the ends which lip over projections on the shank of the drawbar, and it is fastened to the latter by two 1 $\frac{1}{2}$ -inch rivets, excepting on some constructions of draft gear in which the strap has to be taken off to remove the drawbar, in which case bolts are used instead of rivets.

The draft spring, *PP*, as recommended by the M. C. B. Association is 6 $\frac{1}{2}$ inches in diameter and 8 inches long, made of two coils of round steel, 1 $\frac{1}{2}$ and 4 inches respectively, in diameter, the spring to have a total resistance, when fully compressed, of 22,000 pounds, and capable of being compressed 2 $\frac{1}{2}$ inches.

(To be continued.)

Passenger Locomotive for the Great Western Railway.

In the accompanying engraving we illustrate the latest of fast passenger locomotives built by the Great Western Railway of England. Ten of these engines have been constructed at the company's shops at Swindon. They were designed by Mr. W. Dean, locomotive superintendent, and are intended for service on divisions where the grades are heavy and the curves both sharp and numerous.

The engines are somewhat American in appearance, with their four-wheeled leading trucks and extension fronts. The cylinders are 18 inches by 26 inches and are between the frames. The driving wheels are 67 $\frac{1}{2}$ inches in diameter, which is considered rather small in English practice, but was decided upon in this case because of the heavy grades. The boiler is straight and is constructed of steel, with steel tubes. There is nothing

The weight on the main wheels is considerably more than on the rear ones.

The principal dimensions of the engines are as follows:

Cylinders.....	18 inches by 26 inches.
Driving wheels.....	5 feet, 7 $\frac{1}{4}$ "
Truck wheels.....	3 " 7 $\frac{1}{4}$ "
Driving wheel base.....	8 " 6 " "
Total wheel base.....	22 " 3 " "
Diameter of boiler.....	52 $\frac{1}{2}$ inches O. D.
Number of tubes.....	249
Size of tubes.....	1 $\frac{1}{2}$ inches O. D. by 11 feet 3 $\frac{1}{4}$ inches long.
Heating surface of tubes.....	1,385.6 square feet.
" " firebox.....	112.6 " "
Total heating surface.....	1,398.2 " "
Grate area.....	19 " "
Boiler pressure.....	160 pounds.
Weight on main drivers.....	34,400 " "
" " rear drivers.....	23,500 " "
" " truck.....	23,300 " "
Total weight in working order.....	103,100 " "
Tender capacity.....	2,000 gallons.

We are indebted to *Engineering* for our illustration.

Water-Tube Boilers in the British Navy.

Evidently the English Admiralty retain their faith in the efficiency of water-tube boilers, as not only are a large number of new vessels being fitted with various designs of these boilers, but it has also been decided to reboiler No. 80 torpedo boat and the cruiser *Bellona* in each case with water-tube boilers. The *Bellona* is only four years old, and, although this vessel has done very little service, the boilers are reported to be considerably worn. The cruiser *Proserpine*, building at Sheerness, is also to be supplied with water-tube boilers. It is stated that the Thornycroft type will be adopted in this case.

According to *Engineering*, H. M. S., *Vindictive*, a second-class cruiser of 10,000 indicated horse-power, just laid down at Chatham Dockyard, is to be fitted with water-tube boilers of the Belleville type, 18 in number, by Messrs. Maudsley, Sons & Field, Limited, who are making the feed pumps, also of the Belleville type, and the air blowers or compressors for supplying air to each furnace to mix with the gases and aid combustion. The boilers are arranged in three groups, each group consisting of six boilers placed back to back, with the athwartship stokeholds. Each boiler is constructed for a working pressure of 300 pounds per square inch, and consists of eight elements, ten stories high, built of solid drawn steel tubes 4 $\frac{1}{2}$ inches in diameter and seven feet, six inches long. The boxes connecting the tubes are of malleable cast iron. The total grate surface is 880 square feet, and the total heating surface is 25,000 square feet. There are six feed pumps, each capable of feeding six boilers and six air blowers; that is, one feed pump and one blown in each stokehold. The boiler installation is identical with those of the second-class cruisers *Gladiator*, *Furious* and *Arrogant*.

(Established 1832.)

AMERICAN ENGINEER CAR BUILDER AND RAILROAD JOURNAL

27TH YEAR.

65TH YEAR.

PUBLISHED MONTHLY

BY
R. M. VAN ARSDALE,

MORSE BUILDING.....NEW YORK.

M. N. FORNEY,
W. H. MARSHALL, } Editors.

F. H. CLARKE, Advertising Manager.

MARCH, 1896.

Subscription.—\$2.00 a year for the United States and Canada;
\$2.50 a year to Foreign Countries embraced in the Universal
Postal Union.

EDITORIAL ANNOUNCEMENTS.

Advertisements.—Nothing will be inserted in this journal for pay, EXCEPT IN THE ADVERTISING PAGES. The reading pages will contain only such matter as we consider of interest to our readers.

Special Notice.—As the AMERICAN ENGINEER, CAR BUILDER AND RAILROAD JOURNAL is printed and ready for mailing on the last day of the month, correspondence, advertisements, etc., intended for insertion must be received not later than the 25th day of each month.

Contributions.—Articles relating to railway rolling stock construction and management and kindred topics, by those who are practically acquainted with these subjects, are specially desired. Also early notices of official changes, and additions of new equipment for the road or the shop, by purchase or construction.

To Subscribers.—The AMERICAN ENGINEER, CAR BUILDER AND RAILROAD JOURNAL is mailed regularly to every subscriber each month. Any subscriber who fails to receive his paper ought at once to notify the postmaster at the office of delivery, and in case the paper is not then obtained this office should be notified, so that the missing paper may be supplied. When a subscriber changes his address he ought to notify this office at once, so that the paper may be sent to the proper destination.

The action of the Supreme Court in issuing a writ of certiorari in the suit between the Westinghouse and Boyden air-brake companies is significant as being practically an admission of error in the decision of the Circuit Court of Appeals. This is the first patent case, not involving Federal interests or a question of jurisdiction, that has ever, under the method of procedure established by the statute of 1891, been ordered up for further action by the United States Supreme Court. Its decision will be awaited with interest and we trust that when rendered the decision will be so manifestly just to both companies as to be so considered by all parties.

It is popular in these days to decry the methods employed in departments of the government, and perhaps no one department receives more abuse than the patent office. Possibly it deserves some of it, but those who condemn the accumulation of a surplus in its treasury that in many years has risen to only \$4,500,000 should be less hasty. During the last year or two great progress has been made in the classification of patents and in bringing the work up to date, so that there is less delay in the issuance of patents. We recently heard of a patent being allowed in about three weeks after application was made. It is hardly to be presumed that the work of reform is going to cease, and as reforms require money to carry them out, this surplus may actually decrease in the near future. Certainly it is better to urge reasonable reforms, even if they be extensive, than to advocate reduced fees as a means of wiping out the surplus.

In shops where the character of the output is such that manufacturing methods cannot be generally introduced throughout the entire plant, there are usually opportunities to employ these economical methods in the details. A shop that is building a certain line of engines on order, for instance, need not limit the number of small parts made at a given time to the orders then on hand for engines, but can make them up in fifties or hundreds, if too much capital is not tied up thereby. This method of working has been pretty well developed in some railroad repair shops to the profit of the company. To get the fullest benefit from such practices unimportant variation in the details of cars and locomotives must be avoided, and standards departed from only when absolutely necessary. This widens the field for manufacturing in the making of repair parts, makes the demand for any given part more regular, reduces the amount of stock to be carried and the capital tied up in finished parts. This is realized by many, but not every road gives it the attention it warrants, because of a mistaken impression that the number of pieces of any one part

required by it are not sufficient to make such methods profitable, or to pay for the special tools by which the cost for labor is reduced.

After two years of trial, the Pittsburgh, Cincinnati, Chicago & St. Louis Railway has abandoned the "chain-gang" method of handling its motive power, and has returned to the practice of crews to each engine. Whether they are operated with single or double crews depends upon the amount of traffic and the demand for engines. Mr. Swanson, Master Mechanic at Indianapolis, finds by a comparison of accounts for different years that the "chain-gang" system resulted in an increased cost of roundhouse expenses of 11 per cent., that the engines had to be shopped more frequently, the passenger engines averaging about 30 per cent. less mileage between shoppings, and the freight engines 24 per cent. All this happened without any increased mileage per month as an offset. Exact information relative to the different methods of operating is and has been hard to get, and if any of our readers can contribute data of value on this subject we will be pleased to hear from them. One of the great difficulties to be overcome in the "chain-gang" system is the lack of interest in the engines on the part of the men. Mr. Swanson says that the individual crew system makes better machines of the engines, and better men of the crews. With the responsibility for the condition of the machine, he argues, comes a personal interest in it which must result in advancing their knowledge of the engine and making them more valuable men.

On another page we publish an account of interesting experiments made in France with a locomotive having a boiler whose firebox was lined with firebrick. From a theoretical standpoint a firebox devoid of heating surface should give more combustion and prove more economical than one having heat-conducting walls, providing the remainder of the boiler contains heating surface capable of reducing the temperature of the gases at the smokebox to the best practice of to-day. But those who consider the 160 square feet, more or less, of firebox heating surface as indispensable to good steaming qualities, it may appear to be impracticable to depend upon the tubes alone for heating surface. Nevertheless, it has been proved by several investigators working independently of each other that tube-heating surfaces can be relied upon to perform the additional duty demanded of them, without as great an increase in total heating surface as would at first be thought necessary. But while this is all true, our readers may be cautious in accepting the conclusion of the author of the article found in this issue that firebox heating surface can be satisfactorily replaced by an equal number of square feet of tube surface. That results supporting that view were obtained in the trials noted is probably attributable to the duty imposed on the boiler being much less than would be the case in this country. While the rate of combustion is not stated in the article, it is said the coal burned per mile was reduced from 80 pounds to 54½ pounds, and at ordinary speeds of freight trains that would involve the combustion of about 1,600 pounds per hour. As the tube heating surface in the new boiler, which approximately equaled the total heating surface of the old boiler, was 1,399 square feet, it follows that for each pound of coal burned per hour there was .81 square feet of heating surface. The common practice in this country is to load engines with all they can haul and the combustion per square foot of grate and per square foot of heating surface is almost always greater than in Europe. The average combustion here can be safely taken at one pound of coal for not more than .5 of a square foot of heating surface per hour, thus imposing a duty upon the heating surfaces of approximately 60 per cent. more than in the French experiment. Had the boiler been called upon to do the amount of work required in American practice all of the extra heating surface of the new boiler might have been required. While one of the avowed purposes of the test was to determine the durability of the firebrick walls, the author has not stated in his article what mileage was obtained from them.

A NEW ENGLISH LOCOMOTIVE.

On another page we reproduce from *Engineering* a perspective view of a new passenger locomotive, built for the Great Western Railway, by Mr. W. Dean, Locomotive Superintendent of that line. As this engine has some peculiarities, and as it differs very much from American practice in some respects and approaches it in others, a little criticism, comment and comparison with our way of doing things, may not be unprofitable to some of our readers on this side of the Atlantic, nor uninteresting to those on the other. What is proposed is simply to make such comments on these differences of practice, which strike an American, who has taken an active interest in locomotive construction and design, and to point out wherein the English and wherein the American practice seems to have advantages. It may be added that accompanying the view, which is reproduced on another page, *Engineering* gives a double page longitudinal section and sectional plan for which we had not room, but from which much of our information was derived.

As will be seen from the engraving, which is given elsewhere, the engine is of the bogie type with inside cylinders,

and—what is very remarkable for an English engine—an extended smokebox. The wheel base, measured from the center of the truck to the center of the trailing wheels, is 19 feet. An American engine of similar size and weight would be made about 18 inches longer. This difference in length is a marked characteristic which differentiates English from American practice. Apparently the necessity of making the length of their locomotives, which have rigid wheel bases, very short has become a habit, so strong in the minds of our English brethren that it cannot be laid aside when there is no longer any necessity for conforming thereto, or the length of existing structures, such as engine houses, turn-tables and sidings, on their roads, is too short for locomotives of a greater length than they have adopted. All American locomotive men would be unanimous that there is not the slightest need of making our locomotives shorter than they are in order to traverse any ordinary curves found on lines in this country or those on English roads.

The length of the tubes of "The Duke of Cornwall" are 11 feet ¾ inches between tube plates, and 1½ inches in diameter. Longer tubes would have been practicable with a more extended wheel-base, and they then could have been increased in diameter and still retained their evaporative efficiency, with less liability to clogging up.

The inside cylinders and cranked axles are constructive features which would be universally condemned here. In this engine the driving-wheels are small, and as the steam chests and valves are placed below the cylinders, the latter had to be inclined 1 in 10. The opinion, or prejudice possibly, against the use of inclined cylinders on locomotives is so strong in this country that any engineer who would adopt them in the construction of a locomotive, unless it were under very exceptional circumstances, would be regarded here as a superannuated mechanical fossil. Now, it may be that this is an entirely unreasonable prejudice, but of its very general prevalence here there can be no doubt. In England, on the contrary, many, perhaps most, of the ablest locomotive superintendents still adhere to this method of construction. Who is nearest right? The arguments *pro* and *con* have often been stated. It is claimed for the inside cylinder engines that they run steadier, and that their cylinders are better protected from radiation, and also that the framing can be more compact and stronger than with outside cylinders. On the other side is the fact that cranked axles are first much more expensive and more liable to break than straight ones. To lessen this liability Mr. Dean has provided double bearings for the main driving axle, which are inside and outside the wheels. The trailing axle has only outside bearings. The crank cheeks are also reinforced with straps shrunk on them. The double bearings require duplicate frames, journal boxes and driving springs and supplementary outside cranks and pins for the coupling rods. Owing to the large diameter of the inside crank bearing the "big end" of the connecting rod must be about double the linear dimensions and its weight about four times that of a rod for an outside connected engine. On Mr. Dean's engine the forward part of the connecting rods are made with forked ends and double strap bearings—but this is not essential. It is nevertheless expensive, although it makes a good job when finished.

Another objectionable feature is that the firebox must be about a foot shorter with cranked axles—to give clearance for the cranks—than it need be, with outside cylinders. This may not be a serious objection where good coal is used, but with poor fuel the additional length of firebox is important.

Doubtless better drainage of the cylinders is secured, by placing the steam-chests below them, and inverting the slide-valves than there would be if they were placed on top, but in the engine which is now being discussed the steam chests are immediately above the center bolster of the truck, which has an arrangement that permits of its transverse movement in relation to the engine. It is not easy to see how the valve-seats can be faced without removing the truck, and then the workman must operate on an inverted surface like the ceiling of a room. It is to be feared that such an arrangement would cause a good deal of profanity in American roundhouses if that method of construction was generally adopted here. It would be interesting to have an estimate of the cost of a set of cylinders, connecting-rods, crank-axes with duplicate boxes, springs and frames and outside cranks, and then compare it with the cost of the same parts as ordinarily made for outside cylinder engines. What American locomotive engineers would be interested in knowing is the compensating advantage for this difference in cost.

It is of course true that by placing the cylinders between the wheels, and inclining them, and then putting the valves below them, that the links can be connected directly to the valve-stems on a horizontal line drawn through the center of the driving-axle. European designers of locomotives appear to have abhorrence of rocking-shafts and they will resort to all kinds of expedients to avoid their use. Now, as a matter of fact, there is hardly anything about an American locomotive which costs so little to maintain as the rocking-shafts which are used here with link-motion valve-gears, and probably nine master mechanics out of ten in this country would much rather maintain and lubricate such "rockers" than keep up the sliding guides for the valve-stems, which are directly connected to the links as they are shown in the

illustration before us. The bearings of a rocker are cylindrical and are enclosed and are never exposed to dust. A reciprocating guide, on the contrary, has a considerable part of its frictional surface exposed during each stroke and is thus more difficult to keep oiled and more subject to wear. Besides the bearings of the rocker are more accessible, which is an important feature, which leads to the observation that English designers seem to take great pains to hide all appearance of complication, and to do this, are given to putting everything that it is possible to hide inside, where it will be out of sight, or, in the language of St. Paul, they "look on things after the outward appearance." American designers, on the contrary, try as far as possible to put all working parts outside, where they will be accessible.

The boiler of Mr. Dean's engine is made of steel, with steel tubes, the staying of the crown sheet being quite peculiar. The rear half of its surface is provided with transverse crown stays, the general form of which is that of an inverted letter **J**, the vertical and horizontal parts of which are united by a pin connection. The lower portions of each of these **J**'s extends from the outer edge of the crown sheet to the middle and is connected to it by crown bolts. The upper edge of the **J** is attached to the outside shell. The front half of the crown sheet, on the other hand, is supported by longitudinal crown bars, which are only half the length of the crown sheet and each of which has its front end resting on the tube plate, while its rear end is hung from the outside shell or "casing" of the firebox by a pivotal pin and sling stay. Between the two ends the bars are connected to the crown sheet by bolts. "This system," *Engineering* says, "has evidently been adopted with a view of avoiding too great rigidity, and allowing for expansion." With this arrangement the front ends of the crown bars are free to move up or down with the expansion of the tube plate and of the firebox. The back ends are, however, supported by the sling stays, while the part of the sheet between the ends of the bars is supported by the bolts. A somewhat similar action may take place with the transverse **J** stays, the horizontal part of which may rock on its pin connection with the vertical part in case the side sheets are expanded. This method of staying seems to have merits which are well worthy of consideration.

A feature which is worthy of consideration by American engineers is the construction of the driving-springs. These are 3 feet 6 inches long, measured from center to center of hangers, and consist of four plates of 4 by $\frac{1}{2}$ -inch and four plates of 4 by $\frac{3}{4}$ -inch steel. The hangers of both the driving and truck springs are supported by cylindrical rubber pads $5\frac{1}{2}$ and 4 $\frac{1}{2}$ inches diameter and 3 inches thick. These are held in cast-iron cages or boxes, the link hanger being a round rod with a nut and a washer below the rubber, the springs being connected to the upper ends of these hangers by links which permit the free movement of the springs. This is a much better arrangement than is ordinarily provided in American engines, although the absence of equalizing levers between the driving axles would hardly be approved in this country, but with a good road-bed and the excellent arrangement of springs provided by Mr. Dean, it is an open question whether equalizers are essential or important.

The driving tires have safety flanges which lock into grooves in the wheels on the outside, and have retaining rings on the inside, a practice which it would be well for us to imitate more than we do.

The tender and engine truck wheels are of the Mansel wooden disc pattern, 43 $\frac{1}{2}$ inches in diameter. This form of wheel is very extensively used in England, but has never met with favor here. Some years ago they were tried on the Erie road and, we believe, some other lines, but failed. Why is it, it may again be asked, that these wheels are so satisfactory in England but fail here?

From our engraving it will be noticed that the truck axles have outside bearings. This would be impracticable if the cylinders were outside, and as outside bearings certainly have advantages over those inside, this feature may be counted in favor of the inside cylinders. The truck center-pin has a semi-lateral movement which is controlled by spiral springs, and the center-pin has a spherical bearing which permits perfectly free adjustment to lateral or longitudinal inequalities of the road, which cannot be said of our engines, which rest on broad, flat bearings on the trucks.

The exhaust pipe extends from the steam chests—which it will be remembered are below the cylinders—upward between them to a point level with the top row of tubes. This pipe has a division in it which extends from the steam chests to the top of the fifth row of tubes, counted from the bottom, and has a single large nozzle at the top. This arrangement thus seems to have the advantages of both the single and the double nozzles. The chimney projects downward inside the smokebox to a point about half way from its top to the upper row of flues, and has a flaring mouth at its lower end.

Another noteworthy feature is the fact that the engine has two pumps, which are worked from the crossheads, and apparently no injector. It would be interesting to know what led to this reversion to pumps on this line.

The sand-boxes, it will be seen, are placed over the frames, which makes them more accessible and removes them from a position where they obstruct the view and are certainly not ornaments.

A feature of this engine to which the attention of our locomotive superintendents and builders is especially directed is the steps which are provided on the engine and tender. There are, in the first place, two sets of steps, one on the engine and the other on the tender, which are alike and are on the same level. The lower ones are of liberal length and width, and have high flanges on the ends to prevent a person's foot from slipping off. In getting on or off the engine one foot can be securely placed on one step and there is then a place for the other immediately alongside of it. On many American engines the steps are of such a form and size that it is not easy to find them nor to secure a foothold, and they are often not arranged in pairs, so that when the right foot is in place the position for the left one is not obvious. Between the engine and tender the steps are arranged in pairs horizontally and also vertically, or one above the other and with a plate back of them to prevent those mounting the engine from thrusting their feet inward. It should be noticed, too, that the same kind of steps are provided at the back end of the tender, and also between the main driving and truck wheels. These are all alike and on the same level, and for that reason anyone is less likely to make a misstep than they would be when the form, position and size of the different steps are unlike. In this respect this English practice is better, more intelligent and more humane than ours. The number of men who are killed and injured annually from falling off engines and cars is very large. Certainly it is the duty of all who have control of such matters to diminish the risks. Old Ross Winans was in the habit of advising his apprentices in this wise: "Boys," he would say, "if you must make a thing strong, make it d—n strong." It is not needful, perhaps, to imitate the old gentleman's forceful language, but it may be said that if you can make anything safe, then make it as safe as you can. The length and width and depth and location of these English steps certainly gives the men who must use them more security than they can have when what are called "pads" are used, to which Mr. Winans' adjective might properly be applied.

THE REVISED RULES OF INTERCHANGE.

The report of the committee of twenty-one appointed by the Master Car Builders' Association to revise and rearrange the rules of interchange on the lines suggested last year by the Southern and Southwestern Railway Club, has been issued and discussed by several of the railroad clubs. The report recommends a rearrangement of the rules under several headings such as "instructions to inspectors," "instructions to repair men," "instructions for billing" and "miscellaneous." The wording of the old rules has been retained in nearly every case but a few clauses have been introduced to make them conform to the spirit of the new interchange at Chicago, and an attempt has been made, but imperfectly carried out, to indicate responsibility for defects by statements after each section of the rules defining the defects for which cars may be refused.

The result of all this rearrangement is that while the code has gained somewhat in clearness it has lost none of its bulk, and yet such club discussions as we have read have been devoted almost wholly to the correction of sections that were not quite clear in the revision; in fact, nearly every one seems to have fallen in line and advocated the revision without at the same time insisting on condensation. This condition of affairs is much to be regretted, for now is the time to insist on greater simplicity. Delays to freight will not be reduced by simply reversing the phraseology of the rules so that instead of reading that "cars may be refused" for certain defects, they will read that "cars must be accepted" unless certain defects exist; what is wanted, rather, is as simple a code as can be devised on the principle of owner's responsibility. The words of Mr. John McKenzie before the New York Railroad Club should be carefully read by every official that has a vote in the Master Car Builders' Association. He said:

"It seems to me that the code of rules proposed by the Committee of Twenty-one goes as far as possible in the line of getting us deeper into a rut that we have been traveling in for the last ten years, by conglomerating and mixing up a lot of rules that do not assist the object that we have before us—that is, the smooth and equitable interchange of cars. The time has gone past when we can get together and say that you may receive a car, if you want to, and every place where the word 'may' is introduced in this code of rules, the word 'shall' ought to be introduced. Cars can be moved and they can earn money instead of waiting for somebody to make up his mind as to whether they shall put an I O U on the car or not; and it lies with us whether we shall change the rules, and make them so simple and so positive in their operation, that the cars must move, rather than have them stand on the side tracks until a few men who are able to earn a dollar and a half a day shall wrangle and decide whether the car shall move or not. The transportation departments of this country have come to the conclusion that a smooth interchange can be introduced. The Chicago agreement has shown that it can be done. The mileage of the cars has been increased a very large percentage, and the time has come when we must either do something or they will take it out of our hands and let somebody else do it. The transportation departments are ready to-day to take hold and make an interchange that will move the cars of the country."

"There is no question in my mind that all this business of going through the multiplication table, adding to and taking from, going from 1 to 34, and then going through the

alphabet six or seven times from a to z, illustrating all these rules and the interpretation thereof—all this has gone by. We must stop it. What we want to say is that cars shall be offered in a serviceable condition, and they shall be accepted. Make the owners responsible for the defects that follow under fair usage. Under the Chicago agreement we undertake, with about 13 different paragraphs, to cover the entire code of rules, and everything is working smoothly."

A fact which has an important bearing upon this whole business of revision is that the entire Pennsylvania system has gone into the Chicago agreement. This is another way of saying that at the June convention the new interchange will receive the votes of that system and that unless others who supported it last year change their votes it will be adopted this year. With this in prospect there should be a greater condensation of the rules than has thus far been proposed.

The present revision says (section 43) that "owners are responsible for failure under fair usage of any part of the body of the car," and (section 40) that "all defective or missing or worn out parts not already mentioned, which have failed under fair usage (are) chargeable to owners." Now if this is the case why should all of the sections relating to brake gear be retained? If a brake wheel is defective the owner can be billed for a new one without it being specifically mentioned in the rules. It would seem as if most of sections 18 to 39 could be omitted. The elaborately defined and illustrated defects of couplers can also, in the opinion of many practical men, be omitted. It ought to be possible to omit section 52, which says that "locks, grain doors and inside parts of cars are at owners risk, except where damaged by wreck or unfair usage," if section 43, above quoted, means what it says.

There are also some things in the rules the absurdity of which is not appreciated because of long familiarity with them. For instance we are told that cars can be refused if the axles are bent or broken or the collars worn off! Or if a wheel under the car is burst or is loose on the axle! Such rules ought not to be required in this generation, and if they are needed it is a severe comment upon the manner in which interchange is now handled, and is to be handled under the new agreement.

From the discussions on interchange rules one would think that nearly the entire cost of car repairs was involved, but as an actual fact the percentage is quite small. One of the largest systems in the country can show by its accounts that the repairs to its own cars made by foreign roads amounts to but 1.5 per cent. of the total cost of the repairs to its cars and of several other large roads whose figures we have seen none show more than 3 per cent. Though this small per cent. runs into the tens of thousands of dollars any lack of equity in the items composing it are so largely offset by similar bills against other roads, that probably the most ardent advocate of rigid rules cannot show that the least equitable of the rules ever put in force by the association added one-half of one per cent. to the total cost of car repairs through work done on defect cards or in interchange, except as they have compelled the making of unnecessary repairs by the owing road. With such a small percentage of the total cost of car repairs involved in the repairs which foreign roads are empowered to make on the cars of any road, and with a saving in prospect from the reduction in the amount of unnecessary repairs and the avoidance of delays in interchange, it behooves the members of the Master Car Builders' Association to so frame the new rules as to get the full benefit of the change, and to show by such action that are really actuated by that broader spirit of which the adoption of the Chicago interchange is supposed to be indicative.

"Industry."

Those persons whose good fortune it has been to have had the acquaintance with and knowledge of a monthly magazine published in San Francisco and edited by John Richards will regret to hear that its publication will probably be discontinued after January, 1896. In that number the following announcement was published:

"The present publishers of *Industry* will not issue the magazine longer. If a new management assumes the business, proper announcement will be made to its patrons and clients. Five thousand pages of matter, nearly all originally written, have been furnished to our readers in good faith, in candor, and continuous effort toward honesty and truth, but the work is, and has been for several years past, more than their powers permitted, or the patronage of the journal warranted."

"During eight years of publication there has been a great change in the conditions under which a technical journal must be conducted on this coast in order to secure the commercial patronage required to sustain it. The methods are neither congenial to nor consistent with an independent technical publication devoted to matter such as has appeared in *Industry*, nor with the policy first assumed and continually carried out, that of laying before readers useful truths that would promote their interests and business."

"The present issue has been delayed by the illness and absence of the editor. It closes his and the publisher's labors, and it remains to thank many warm friends who have encouraged and promoted *Industry*."

There is a pathetic tone about this, which will perhaps express the feelings of other editors as well as those of the

author of what is in reality a valedictory, or the antonym of an announcement. *Industry* has been one of the most delightful publications that reached our pile of exchanges. It came each month with the fresh characteristics which were infused into it by the original work of its editor. Unlike most other publications, its contents consisted largely of matter written by him, who each month gave his readers the most interesting and instructive comments on current engineering subjects. Research need not be carried very far among his contemporaries to find others to whom the methods and conditions which must now be adopted or complied with "to secure commercial patronage are not congenial" nor appear to be consistent with independent technical journalism. Whether it was this reason or that of ill-health—vaguely hinted at—which has led the author of the charming articles in *Industry* to abandon the editorial field, it will in either event be much regretted by those who know him or his publications, and still more by those who know them both.

The South-west Railway Record and Engineering News.

We are in receipt of a copy of No. 6 of this—to us—new publication, issued in Kansas City, with a request to exchange which will be cheerfully acceded to. The paper is neatly printed, and has a sort of an enterprising and "hustling" tone about it which is indicative of its Western habitat. As will be seen, it has adopted as its sub-title that of one of our New York contemporaries. This appropriation is, however, regarded in this office with equanimity, for the reason that the journal which has thus been despoiled of its good (?) name was guilty of a similar act some years ago in adopting "*Railway Journal*" as its sub-title, which is substantially the name under which this paper had been published for over 50 years, and which is still retained. The court refused to right the wrong, and our friends in Kansas City can now appeal to its decision, if they are disturbed in the possession of that which our sense of integrity compels us to admit is not fairly theirs, any more than *Engineering News* of New York is entitled to use *Railway Journal* as part of its title.

Notes.

Many of the cases submitted to the Arbitration Committee of the M. C. B. Association for settlement are so simple that it is a matter of surprise that they were ever presented to that body, but in the latest report of the committee there is a case of considerable importance. It is Number 323 and is between the C., C. & St. L. and the Terre Haute & Indianapolis R. W. In July, 1895, an elevator located on a siding connecting with the T. H. & I. Ry., was destroyed by fire, and several cars burned, among them two C., C. & St. L. cars. The latter road has a contract with the T. H. & I. Ry., by which its cars are delivered on this siding to be loaded and re-delivered to the C., C. & St. L. Ry., for a switching charge of \$1.50 per car paid to the T. H. & I. Ry. In the case of the two cars burned, it happened that the C., C. & St. L. train crew with their own engine switched the cars over the other company's tracks and onto the siding, because there was no T. H. & I. crew on hand at the time to do the work. The switching charge was paid, of course, just the same as though the switching had been done by the other road. The T. H. & I. Ry. claimed that it did not deliver the cars onto the siding as per rule 28, while the C., C. & St. L. Ry. claims that in doing the switching it was only acting for the other road, and that the road owning the tracks connecting to the siding is and is the only party that can be expected to have a contract with parties owning the siding covering loss by fire. The Arbitration Committee decided in favor of the C., C. & St. L. Ry., saying: "If the owners of the track had actually made the delivery there would not, under the rules, have been any room for dispute, nor is it believed that the fact of another road having attended to the work for the track owner and having paid them for it alters the case."

A compound engine of 10 horse power and weighing, with its pumps, 185 pounds, was recently exhibited in England. It was built for a launch and makes 600 revolutions per minute with a steam pressure of 250 pounds.

At the Lake Shore shops at Englewood, Chicago, Mr. T. Fildes bends air-brake train pipes on the bulldozer. The pipes are first cut to proper lengths and then bent by the use of suitable dies. After a large number of pipes are bent and stacked up, a man turns a steam jet into each pipe, thus removing any scale or dirt that may be in them.

The *Railway World* is authority for the statement that on the London & South Western Railway the oil lanterns carried by ticket collectors and by the light of which they were enabled to decipher passengers' tickets, have been superseded by small electric lamps, which are fixed on the overcoats of the collectors and supplied with current by a small accumulator carried in the breast pocket. A month's experiment is to determine whether the innovation is an improvement, and if the officials find it such, the electric

lamps will be generally adopted. It is said that on several omnibus lines similar apparatus have proved a convenience greatly appreciated by conductors.

A \$200,000 steel steam yacht for Mr. P. A. B. Widener, of Philadelphia, is under construction at the Crescent shipyard, Elizabethport, N. J. It is 225 feet long, 183 feet long on the water line, 28 feet beam, and draws 11 feet 6 inches of water. The displacement is 800 tons. There is a steel house on deck 135 feet long and 18 feet wide, over which is a promenade deck. The engines are to be triple expansion, with cylinders 18, 27 and 42 inches in diameter and 28 inches stroke. Two Scotch boilers will furnish steam at 175 pounds pressure, and it is expected that 1,250 horse power will be developed. The capacity of the coal bunkers is 210 tons. An electric lighting plant and a refrigerating plant will be installed. The furnishings will be costly, and when completed the owner intends taking his family in it for a trip around the world.

The use of liquid fuel has been so extended on the Great Eastern Railway (England) that a large storage plant has been erected at Stratford. Twenty-five locomotives are now fitted with oil burners under the Holden system, and 12 stationary boilers and three furnaces at the shops burn the same kind of fuel. The oil arrives at Stratford in bulk, old locomotive tenders being employed in transporting it at present. The storage tanks are 13 in number and are placed on low ground not very far from the main line. The oil flows to them by gravity. A peculiarity of the tanks is their rectangular shape. Nine of them hold 3,000 gallons each and the remaining four 2,500 gallons each, making a total of 37,000 gallons storage. From these tanks oil is pumped to an elevated tank of 4,000 gallons capacity (also rectangular) from which it is taken for consumption. Locomotives burning 35.4 pounds of coal per mile perform equal duty upon 16.5 pounds of oil per mile, and if the fuels are mixed the engines will average 11.8 pounds of coal and 10.5 pounds of oil per mile.

A committee of the Association of American Steel Manufacturers has asked the Board of Supervising Inspectors of Steam Vessels at Washington to amend the present specifications for steel boiler plate by striking out Section 13 relating to test pieces, and putting in their place four paragraphs which specify that steel for marine boiler plates must be made by the open-hearth process, and be of domestic manufacture; that the test pieces used to ascertain its strength shall be 1 inch wide at the reduced section, and 9 inches long with 2-inch radii connecting the reduced section with the ends, and that said ends shall be 1½ to 2 inches wide and from 4 to 6 inches long; that before placing the test piece in the machine punch marks shall be placed at intervals of 1 inch, and the length in which the elongation is measured shall be taken as nearly equal as possible on both sides of the fracture; in plates less than ½ inch in thickness this length shall be 2 inches; in plates ½ inch thick and up to ¾ inch it shall be 4 inches; in plates ¾ inch to 1 inch inclusive it shall be 8 inches, and in plates over 1 inch it shall be 6 inches. It is also suggested that the maximum figure which can be stamped upon the steel as indicating its tensile strength shall be 60,000 pounds per square inch, and the factor of safety in all cases shall be five. The committee also recommend that the board place a limit upon the amount of phosphorus and sulphur allowable in plates, as under the present rules of the Board it is possible for a manufacturer to use a metal for boilers which would not be accepted by the majority of engineers for the most important work, and it is considered certain that such a clause would be a long step in the direction of a much better and safer metal, while it would not materially enhance the cost. As to the limit of 60,000 pounds for tensile strength, the committee say that under the present law there is nothing to prevent a boiler maker from ordering steel with a tensile strength of 70,000 pounds, or even 80,000 pounds, per square inch, and using a proportionately high steam pressure. This material is considered dangerous by the manufacturers. In asking that the factor of safety be made five, it is claimed that while the factor is now nominally six, it is based upon the strength as exhibited by a grooved test piece, which always gives results higher than the actual strength, and by making the factor five and basing it upon the strength as derived from a parallel-sided test piece the actual factor of safety is the same as in the past.

A test of steam pipe coverings was recently conducted under the auspices of the Boston Manufacturers' Mutual Fire Insurance Company, by C. L. Norton, the results of which are given in the following table, in which the losses are expressed in ratios, that from a bare pipe under 200 pounds pressure being given as unity:

200 pounds steam pressure.	Loss.	10 pounds steam pressure.	Loss.
Nanpariel cork.....	0.254	Nanpariel cork.....	0.232
Magnesia.....	0.281	Air cell 2.....	0.261
Air cell 1.....	0.284	Magnesia.....	0.262
Air cell 2.....	0.300	Magnabestos.....	0.383
Magnabestos.....	0.321	Fire felt.....	0.395
Fire felt.....	0.333		
Calcite.....	0.423		
Bare pipe.....	1.000		

The method of making the test was novel. A piece of double thick steam pipe four inches in diameter was filled with oil and a suitable stirring apparatus inserted through the upper end, the pipe occupying an upright position. A

coil of wire was also immersed in the oil and connected to an outside circuit. A thermometer, voltmeter and ammeter completed the apparatus. By turning on an electric current until the heating coil raised the oil to the required temperature and then regulating the current until the temperature was maintained exactly, the heat furnished by the current was evidently equal to that lost by the pipe, and could be calculated from the current readings. The materials tested were applied to the outside of the cylindrical part of the pipe, the ends being protected by the same blocks of calcite, four inches thick, throughout all the tests. The thicknesses of the protecting materials are not given.

The Brooklyn & New York Ferry Company, which operates the Grand Street Ferry, has contracted with John B. Roach for two more ferryboats similar to the three recently built for them at the same yards. The new boats will be built of iron instead of steel, the latter material being considered better calculated to resist the action of the acids and other corrosive materials poured into the East River from the sewers of New York and Brooklyn. They will be double-deckers, 168 feet long, 36 feet 6 inches moulded beam, 62 feet over the guards and 14 feet 6 inches depth amidships. They will be driven by condensing engines and have single boilers 10 feet 6 inches in diameter and 28 feet long. The wheels will be 19 feet 6 inches in diameter. The boats will be supplied with gas and electric light plants and steam steering apparatus, and will be handsomely finished throughout.

Figures compiled by the Glasgow *Herald* show that there has been a steady decrease since 1891 in the number of men employed in the locomotive building industry of Great Britain. In 1891 the number of men engaged in this line of work was 11,803; in 1892, 9,971; in 1893, 9,043; in 1894, 8,251, and in 1895, 8,473. Part of this falling off is accounted for by the smaller export business, other countries doing more of the building for themselves.

Underfeed stoking, which means that the fuel is fed upward beneath the fire, instead of placed on top, is an extremely common-sense method if considered in the abstract. In the concrete it involves apparatus that is not a desirable adjunct to a steam furnace, also involves artificial or forced draught, but even on those conditions there is strong probability of survival of the system.

There is a conflict of conditions or principles in this matter of heating furnaces that it will be hard to reconcile. If the draught is upward, and the fresh fuel fed on top, the combustion is wrong-end foremost and smoke unavoidable. If downward, the fuel sustaining part, the grates, are burned out; horizontally a draught through a deep stratum of the fuel is impossible.

The subject has come with increasing interest during ten years past, and while there has been no distinct invention or method that can be called satisfactory, it is a good deal to have gained the admission that improvement must be made.

Some years ago, when in Portland, Ore., we came across a steam furnace burning wood for fuel, the supply being forced through a tube under the grates. The impression at the time was, that there was a scheme that might possibly find wide extension in future, and the subject is again brought to mind by a circular received from the Jagoda Furnace Company, of Portland, Ore., relating to under-feeding furnaces, with tabulated results from various places where their system has been applied.

As now arranged a steam piston is employed to push in at intervals a charge of fresh coal beneath the fire, air being supplied by means of fans.

The Edison Electric Light and Power Company, of this city (San Francisco), have equipped their new boilers with this apparatus for underfiring; so also the Omnibus Cable Railway, and as these large plants are under the care of able and conservative engineers, there is no doubt of the practical working and economy of the system.

It is a fertile field for invention, this fuel burning, and it seems strange to see a struggle after a few per cent. of increased efficiency in steam engines when ten times as much can be, and is, lost or saved by methods of firing.—*Industries.*

Trade Catalogues.

[In 1894 the Master Car-Builders' Association, for convenience in the filing and preservation of pamphlets, catalogues, specifications, etc., adopted a number of standard sizes. These are given here in order that the size of the publications of this kind, which are noted under this head, may be compared with the standards, and it may be known whether they conform thereto.

It seems very desirable that all trade catalogues published should conform to the standard sizes adopted by the Master Car-Builders' Association, and therefore in noticing catalogues hereafter it will be stated in brackets whether they are or are not of one of the standard sizes.]

	STANDARDS.
For postal-card circulars.....	3¼ inches by 6¼ inches.
Pamphlets and trade catalogues.....	3¼ inches by 6 inches.
Specifications and letter-paper.....	6 inches by 9 inches.
	9 inches by 12 inches.
	3¼ inches by 10½ inches.

CATALOGUE OF LOCOMOTIVES. COOKE LOCOMOTIVE AND MACHINE COMPANY. Paterson, New Jersey: 1905. 71 pages, 8 by 9 inches. (Standard size.)

This old established company, in conformity with the practice of other establishments, has issued a "catalogue" which is a good deal more than its name implies. It is in fact to some extent a history of its founder, and of the company of which he was the head, and the works which he originated, and it then describes the products of that establishment.

The frontispiece is a portrait showing the genial and

kindly face, which some of us older numbers can recall with so much pleasure. It gives a brief biography of him, and states a fact which is probably not generally known, which is, that he was a native of Montreal.

Views of the works in 1882, 1883 and 1895 are given with a historical sketch of their origin and development. The present establishment and its facilities for doing work are then described, with views of the office, the inside of the machine shop, the erecting and boiler departments and the hydraulic flanging press, with samples of the work done on it. A view of the inside of the foundry and the transfer table with a rotary snow-plow—manufactured by this company—on it, are also shown. A view is also given of a 40-foot water-wheel, which is also one of the products of these shops. This is followed by a general description or blank specification of a locomotive.

The second part of the book has the title "General Description of Some of the Locomotives Built by the Cooke Locomotive and Machine Company," and gives a series of views—half tone engravings—of eleven different kinds of eight wheeled or American type of engines, eleven ten-wheelers, seven "Moguls," five "Consolidations," four diagrammatic views of the latter class, four half tone engravings of six-wheeled switching engines and six diagrammatic views of four-wheeled "switchers." The book ends with tables giving the dimensions of the different engines built by the company. The catalogue is printed on heavy paper, and on one side of each leaf only, so that it is larger than the number of pages would indicate.

We are inclined to question the propriety of this. In these days of multiplicity of literature, economy of space should be aimed at. It would be a distinct advantage if this—and other catalogues—occupied only half as much space as they now do on our bookshelves, and the mere bulk of a book is often a reason why it is not preserved. The printing, paper and binding are all admirable, but some of the illustrations are hardly up to the highest standards of excellence of to-day. If catalogue makers would only know how much a coat of dull, lead colored paint, on the objects photographed, would improve their pictures, they would have much better illustrations than they now have. If, for example, the hydraulic flanges illustrated in the book before us had been painted in that way before being photographed, the pictures of it would have been immensely improved. It may also be suggested that the attendants, shown in their positions, ought also to have had a coat of some kind of paint before their portraits were taken, so that they would look a little less like New Jersey politicians than they now do. The catalogue is in excellent taste, and serves its purpose of making known the kind and character of work done in this establishment. A supplementary notice pasted in it announces that Messrs. Bryan & McKibbin, of 120 Broadway, New York, have become the general sales agents of the company.

CHAIN BLOCKS. *The Yale & Town Manufacturing Company.* 44 pages, 6½ by 8 inches. (Not standard size.)

CASE'S IMPROVED PROPELLER WHEELS. A. Wells Case, Highland Park, Conn.; 41 pages, 5½ by 7¼ inches. (Not standard size.)

BEAMAN & SMITH, Providence, R. I., designers and makers of machinery and tools. Catalogue D. 64 pages, 3¼ by 5½ inches. (Not standard size.)

The class of tools illustrated in this catalogue and which is manufactured by this firm includes chiefly milling, drilling and boring machines, with a few lathes of standard type. Some 25 different patterns of tools are illustrated and described. They are represented by very good wood engravings, printed on a light green ground. The latter feature does not seem to be a happy invention, although the character of the machines is clearly shown and the descriptions are full and satisfactory.

SOMETHING ABOUT WESTINGHOUSE ENGINES. 12 pages, 3¼ by 5½ inches. (Not standard size.)

The purpose of this little pamphlet is to describe the thoroughness with which this company tests its finished engines before they are sent away from the shop. To this end views are given of their engine testing room, and another of the surface condenser, and weighing tanks employed. The methods of testing are described, and the objects arrived at are set forth.

TOBIN BRONZE. The Ansonia Brass and Copper Company, Manufacturers, New York. 36 pages, 3¼ by 5½ inches. (Not standard size.)

DIAMOND GRINDING MACHINERY FOR ALL METALS, CATALOGUE No. 15. Diamond Machine Company, Providence, R. I. 64 pages, 5½ by 9 inches. (Not quite standard size.)

From this catalogue the reader can get some idea of the variety of purposes for which emery wheels are used, which are indicated by the number of different kinds of grinding machines which this company makes. Over 50 different machines are here illustrated by good wood engravings with brief descriptions and statements of the uses for which the machines are intended. Any mechanic will be sure to get some new idea of methods of doing work, by looking through this book and becoming acquainted with the special machines which are made for special work.

The publishers evidently intended it to be of standard size, 6 by 9 inches, but the binder trimmed it to 5½ inches. We have often wondered that cases of homicide of book-binders is not more common. With the most careful instruction about trimming books, they will often spoil them by cutting away the margin, apparently out of pure cussedness.

WIRE ROPE TRANSMISSION IN ALL ITS BRANCHES. The Trenton Iron Company, Trenton, N. J. Cooper, Hewett & Co. New York. 68 pages, 5¼ by 8 inches. (Not standard size.)

This is what may be called a trade treatise, but as it bears the imprint of 1892, is apparently an old publication with new covers, and therefore hardly demands extended notice. The title page says it relates to Wire Rope Tramways, with special reference to the "Bleichert" and "Acme" Patent Systems; also, Single-Rope Tramways, Patent Cableways, for Quarries, Open Cut Work, Ferries, etc. Wire Rope Outfits for Shafts, Inclined Planes, Underground Haulage Plants, etc., and Power Transmissions. It is illustrated with many engravings showing views and details of wire rope "plants." Some of these illustrations are excellent, but others cannot be highly commended. Altogether, though, it is an admirable publication and is an indication that in the future every trade catalogue will be an elementary treatise on the art to which it relates.

Personal.

Mr. E. M. Dickey has resigned as President of the Hot Springs railroad.

E. S. Jemison, President of the Houston, East & West Texas, died last month.

Mr. H. M. Comer has been elected President of the Central Railroad of Georgia.

Mr. William Davis, President of the San Antonio & Gulf Shore Railway has resigned.

Mr. Dwight M. Philbin, General Manager of the Duluth, Missabe & Northern Road, has resigned.

Mr. M. V. Meredith has been appointed General Manager of the South Haven & Eastern Railway.

Mr. W. H. Young has been appointed Master Mechanic of the Southern Railway at Sanford, Fla.

Mr. Stanley E. Russell, representative of the Q. & C. Company at Atlantic, Ga., died on Feb. 13.

Mr. T. R. Foster has accepted the position of Mechanical Engineer on the Denver & Rio Grande, at Denver, Colo.

Mr. Geo. Thompson has been appointed Master Mechanic of the Beach Creek road, vice Mr. La Mott Ames, resigned.

Col. W. P. Thompson, President of the Ohio River Railroad, died suddenly of pneumonia in New York City, on Feb. 3.

Mr. T. C. Sherwood has been appointed General Manager of the Kansas City, Pittsburgh & Gulf Railway with office at Kansas City.

Mr. F. G. Wheeler has been appointed Purchasing Agent of the Oregon Railway and Navigation Company, with office at Portland, Ore.

Mr. W. J. McLean has been appointed Master Mechanic of the Third Division of the Plant System, with headquarters at Montgomery, Ala.

Mr. Albert G. Blair, who has been General Manager of the Wheeling & Lake Erie since 1892, has been chosen President, to succeed Mr. F. R. Lawrence.

Mr. John H. Winder, General Manager of the Seaboard Air Line, has retired from that office, and its duties will be combined with those of the vice-presidency.

Mr. A. D. Ward has been appointed Purchasing Agent of the Chicago Great Western, with headquarters at St. Paul, Minn., in place of Mr. John Warwick, resigned.

Mr. J. Forster, Assistant Master Mechanic of the Atchison Topeka & Santa Fe at Argentine, Kan., has been appointed Master Mechanic of that road at La Junta, Colo.

Mr. C. H. Hudson, Chief Engineer of the Southern Railway, has also been appointed Mechanical Engineer of that road, with advisory duties in the motive power department.

Mr. James McCrea, First Vice-President of the Pennsylvania lines west of Pittsburgh, has also been chosen president of the Terra Haute & Indianapolis, to succeed Mr. W. R. McKeen.

Mr. Edwin C. Hiser, Master Mechanic of the New York Central & Hudson River, the Rome, Watertown & Ogdensburg, and the Adirondack & St. Lawrence, with office at Utica, has resigned.

On account of bad health, Mr. J. D. Campbell has resigned the position of Master Mechanic of the Buffalo & Susquehanna Railroad to take effect upon the appointment of his successor.

Mr. C. M. Lawler has resigned the position of General Manager of the Philadelphia, Reading & New England Railroad, and Mr. W. J. Martin, formerly General Freight and Passenger Agent, succeeds him.

Norman J. Paradise, General Master Mechanic of the Hannibal & St. Joseph, and St. Louis, Keokuk & Northwestern, died at his home in Hannibal, Mo., in January. He had been with the Burlington system since 1859.

Mr. J. B. Swann, General Foreman of car repairs of the Pittsburgh division of the Pennsylvania lines at Dennison, O., has been transferred to Columbus, O., as General Foreman of Car Repairs, to succeed Mr. John Commerford, resigned.

Mr. John H. Orchard has been appointed Master Car Builder of the Pennsylvania Division of the Delaware & Hudson Canal Company, and of the Gravity Railroad with headquarters at Carbondale, vice Mr. Thomas Orchard, deceased.

Mr. E. M. Roberts has been appointed Master Mechanic of the Southern Iron Car Line, with office at Atlanta, Ga. Mr. Roberts was Superintendent of Motive Power of the South Carolina Railway for some years, but resigned that position in 1894.

Mr. Willard Kells, son of the late Ross Kells, has been appointed Master Mechanic of the Erie shops at Cleveland, O. Mr. Geo. Donahue, who formerly occupied the position, has been transferred to Meadville, Pa., to succeed Mr. F. B. Smith, resigned.

Mr. W. R. Setchel has been appointed Master Mechanic of the Wheeling & Lake Erie Railroad, to succeed Mr. O. P. Dunbar, with headquarters at Norwalk, O. Mr. Setchel is the son of Mr. J. H. Setchel, General Agent of the Pittsburgh Locomotive & Car Works.

Mr. F. W. Brazier, formerly Superintendent of the Chicago, New York & Boston Refrigerator Company, and located at Elsdon, Ill., has been appointed General Foreman of the Car Department of the Illinois Central Railroad and will have charge of all car work at the new Barnside shops of the company.

Mr. W. J. Spicer, General Manager of the Chicago & Grand Trunk, the Detroit, Grand Haven & Milwaukee, and other Grand Trunk roads west of the Detroit River, has resigned, after 12 years of service in that position. The duties of the office will be performed by the General Manager of the Grand Trunk at Montreal.

Mr. Arthur M. Parent has been appointed Manager of the Pullman Works of the Pullman Palace Car Company, to succeed Mr. Harvey Middleton, who resigned in January. Mr. Middleton was with the company since 1891, previous to which he had occupied prominent positions in the railroad service, among which were the positions of Superintendent of Motor Power on the Union Pacific, on the Atchison, Topeka & Santa Fe and on the Louisville & Nashville.

Mr. R. D. Wade has resigned from the position of Superintendent of Motive Power of the Southern Railway, and Mr. W. H. Thomas has been appointed his successor. Mr. Wade began his railroad career in 1857, and since that date has been on Southern roads and chiefly on lines now in the control of the Southern Railway. Mr. Thomas was Superintendent of Motive Power of the East Tennessee, Virginia & Georgia before it was absorbed by the Southern Railway.

Mr. John K. Cowen, formerly General Counsel for the Baltimore & Ohio Railroad, has been elected President of the road. Vice-President Orlando Smith has resigned, and his place has been filled by the appointment of Mr. Oscar G. Murray, formerly Second Vice-President of the Big Four. Mr. Smith retains the Presidency of the Baltimore & Ohio & Chicago Railroad, the Pittsburgh & Connellsville Company, and the Parkersburg Branch Railroad Company, and other branch lines of the Baltimore & Ohio. Second Vice-President T. M. King has also resigned, and has accepted the Presidency of the Baltimore & Ohio Southwestern.

Mr. C. C. Waite, President of the Columbus, Hocking Valley & Toledo Railway, and who for more than a week had been ill of pneumonia in his private car at Columbus, O., died on Feb. 21. Mr. Waite entered railroad service in 1864, and became Chief Engineer of the Cincinnati & Muskingum Valley in 1869, with which road he remained until 1881. For one year he was assistant to the President of the New York, Lake Erie and Western, and from 1882 to 1889 he held the position of Vice-President of the Cincinnati, Hamilton & Dayton. In 1889 he was made President of the Hocking Valley, which position he held at the time of his death.

Mr. F. D. Adams has resigned the position of Master Car Builder of the Boston & Albany Railroad, on account of advanced age. He was born Aug. 30, 1822. He began car work in 1847 and entered railway service in 1859. From 1859 to 1868 he was Master Car Builder of the Buffalo & Lake Erie Railroad, now a part of the Lake Shore & Michigan Southern, and for the next two years was Superintendent of the Ohio Falls Car Company. In 1870 he was appointed to the position he has just resigned. He has always been active in association and club work, and was one of the founders of the Master Car Builders' Association. Though retired from active service, his many friends will be pleased to again meet him at the conventions of this Association, in which he has been such a familiar figure.

Box Car of 60,000 Pounds Capacity with Steel Sills
—Chicago, Burlington & Quincy Railroad.

The box car of 60,000 pounds' capacity that has been standard on the Chicago, Burlington & Quincy Railroad for several years past has the draft rigging on the center sills, the drawbar stem passing through the end-sill. This construction, combined with an excellent draft gear, gave perfect satisfaction. But the mechanical department believes that some day dead-blocks will be used in conjunction with M. C. B. couplers, and to apply dead-blocks to cars with draft gears between the sills would require them to be above the plane of the floor sills. For this reason the standard design was modified recently, and the floor of the car raised with reference to the coupler and draft gear.

In making the change it was decided to keep the draft gear on the center sills as heretofore, and consequently these sills were placed six inches lower than the intermediate and side sills, and filling blocks or timbers extending the whole length of the car were fitted between them and the floor. This requires about the same amount of material as where ordinary draft timbers are employed and filling pieces under the sills are employed to make them practically continuous for the length of the car, but the single and more substantial piece of timber is in this case placed in the direct line of thrust from the draft and gear without impairing its utility as a floor beam.

The mechanical department then went a step further and built a sample car, in which the center sills are steel channels, as shown in the accompanying illustrations. They are placed in the same position as the wooden sills referred to above, except that their tops are only 5 inches below the floor because of the greater depth of the channels. The latter are 10 inches deep and weigh 25 pounds per foot. Fig. 1 contains cross-sections at the bolster and needle beam and shows clearly the arrangement of parts. The bolster is very deep, 16½ inches over all at the center, and its plates 10 inches wide. Castings between the center and intermediate sills strengthen the bolster and cause it to retain its strength and stiffness regardless of any shrinkage of the wood. Between the center sills a wrought iron strap of ½-inch by 10-inch iron unites the parts, and outside of the intermediate sills a casting fills the space between the plates of the transom and takes the pressure of the side bearing. The construction at the needle-beam is clearly shown. The 2-inch timber between the intermediate and side sills only extends from one needle-beam to the other. Straps ½ inches by 3 inches unite the center sills at each needle-beam.

One thing is noticeable from Fig. 3 and that is the absence of bolts or rivets in the flanges of the channels. This has been done to avoid weakening them. From Fig. 2 it will be seen that between the ends of the center sills and the inside faces of the end sills a ½-inch plate is inserted and the channels are secured to it by angle iron brackets. A detail of one-half of the plate is given. This Fig. 2 also shows the draft gear, which has been such a success and which originated on this road. The stops are steel plates bent over double and are riveted to steel cheek plates, the ends of which are bent out to help retain the stops in place. The whole is riveted to the inside faces of the channel sills. The carrier irons are double and the dead wood is protected by a 4 by 4 by ½-inch angle iron, as shown.

This box car is probably the first one intended for regular service to be equipped with steel center sills, and marks another advance in the use of metal in car construction. The road has for some time used steel channels for the center sills of tender frames.

Daniel Kinnear Clark.

The death of Mr. Daniel Kinnear Clark severs another of these links with the railways of the past now all too few. Albeit he never carried out any great engineering work, he was a noteworthy man, and will not soon be forgotten. He died at his residence, 8 Buckingham street, Adelphi, on Jan. 22, aged 74. Of his early years and parentage little is known. We first hear of him as an apprentice in the Phoenix Iron Works, Glasgow. Subsequently he was an assistant to Mr. Miller, who had an extensive practice as a civil engineer in Edinburgh. Mr. Miller had a good deal to do with railways, and after young Clark had been with him for three years, he was appointed Locomotive Superintendent to the Great North of Scotland Railway. While there he was diligent in obtaining information on the performance of locomotives, consumption of fuel, train resistance, etc. For some reason, however, probably inherent in the man, he does not seem to have taken kindly to practical engineering. So long as experiments or investigations were to be carried out or conducted, he was happy; but the everyday routine duties of an engineer in a responsible position did not appear to suit him. He had a strong literary bent. In 1855 he published his book on the locomotive engine and the machinery of railways. Nothing so complete and altogether satisfactory had been published before; nothing equal to it has appeared since. To this moment Clark's book is a standard work of reference. Of course, the lapse of time has rendered much that it contains obsolete. Locomotives of much greater power than Clark dreamed of are running, but the fact remains that Clark made scarcely any mistakes.

The success of his book was so great that Mr. Clark left the Great North of Scotland Railway and started in business as consulting engineer in London. In 1857 he established himself in 8 Buckingham street, Adelphi, and there for

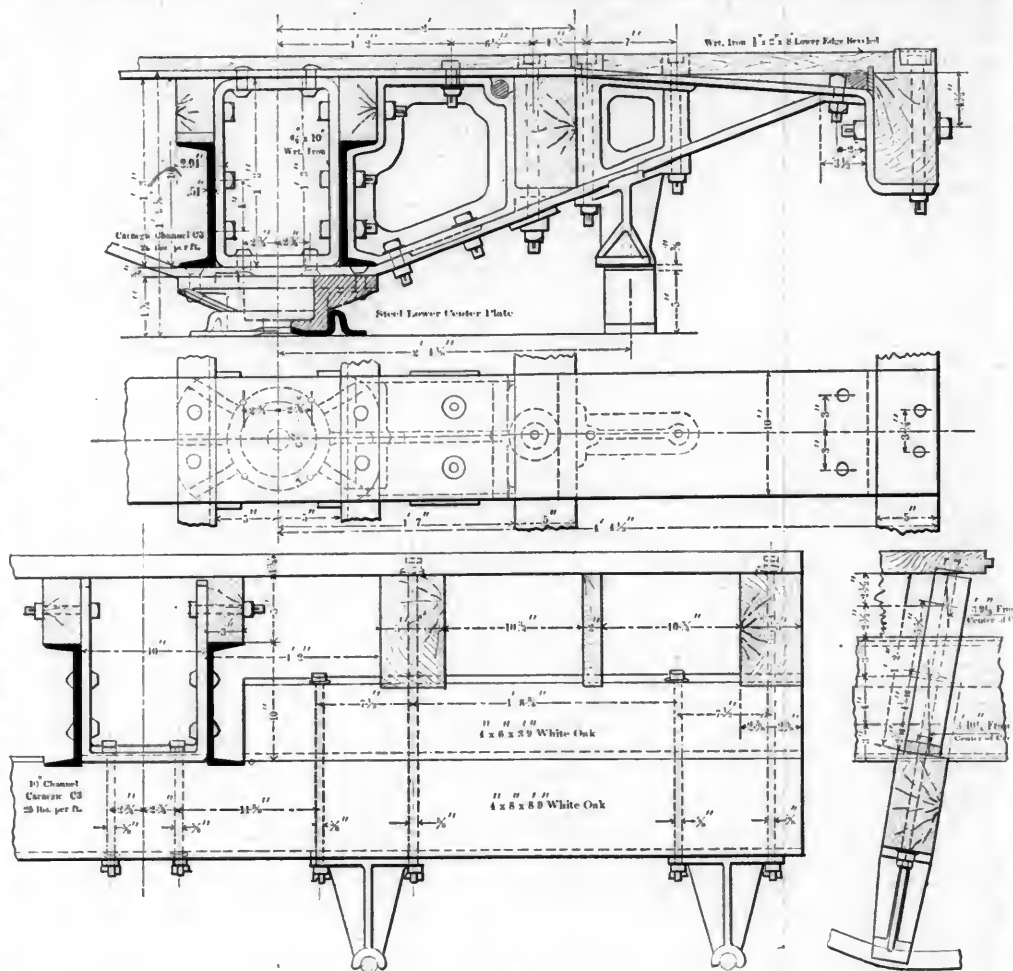


Fig. 1.

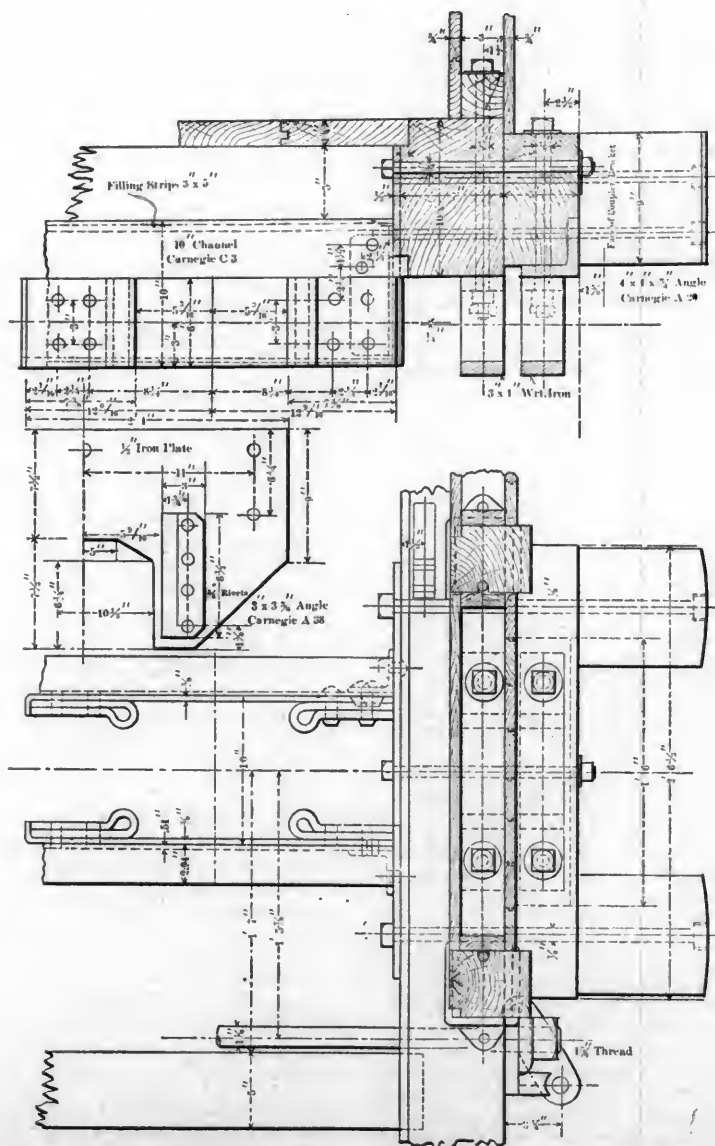


Fig. 2.—Box Car of 60,000 Pounds Capacity with Steel Sills.—Chicago, Burlington & Quincy Railroad.

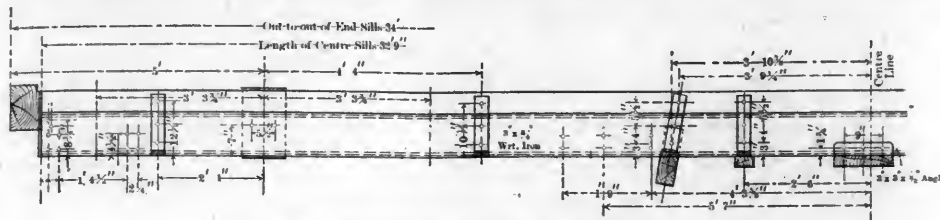


Fig. 3.—Steel Sill for Box Car.—C. B. & Q. R. R.

forty years he lived and worked. Of how few can a similar story of long residence be told? The fact bears testimony to the remarkable adhesiveness of the man. He had no desire to wander; he did curiously little to bring himself into notice, and yet where is the engineer of the last generation who did not know D. K. Clark either personally or by reputation.

In 1861 it became necessary to appoint an engineer to take charge of the machinery department of the International Exhibition of 1862. The choice devolved on Mr. Clark, and he carried out the work and discharged the duties with a skill and tact and an absence of friction worthy of all praise. His employment at the exhibition just suited him, and he there conducted several experiments, the most noteworthy perhaps being a trial of centrifugal pumps. Then he wrote a book, "The Exhibited Machinery of 1862," which, if it did not add to his reputation, constituted a most useful volume for reference.

During the next few years we find him acting as judge for the Royal Agricultural Society and carrying out experiments, almost always in connection with steam or fuel. In connection with the Smoke Abatement Exhibition at South Kensington in 1881 he conducted an elaborate series of experiments and his treatise on the subject, embodying the results of his experiments, may be said to contain all that is known or worth knowing concerning the domestic consumption of fuel.

But before this, that is to say in 1877, he produced the book which will do more to keep his name alive than any other which he wrote; we refer to "A Manual of Rules, Tables and Data for Mechanical Engineers." Those who have this volume—and they include, no doubt, the great majority of mechanical engineers—know that there is no other work like it. Is it not a volume in which we can always find just the information sought? Of how many reference volumes can that be said? The work has gone through several editions. In 1878 he brought out a small volume on "Tramway Construction," subsequently much enlarged and improved, and in 1892 his work on "The Steam Engine and Boilers," which deserves to rank with the very best treatises ever written. This was the last work of any importance Mr. Clark accomplished. During the last few years his health has been gradually failing; of late years he lived a very retired life and was seldom seen in public. He was a member of the Institution of Civil Engineers, joining that body as far back as 1854, and he contributed to it no fewer than eight papers, among which those on the "St. Gothard Tunnel," "Railway Locomotive Stock" and "The Evaporative Performance of Steam Boilers" deserve special mention.—*The Engineer.*

The Most Advantageous Dimensions for Locomotive Exhaust Pipes and Smoke Stacks.

BY INSPECTOR TROSKE.
(Continued from page 31.)

The results obtained from the experiments described in our last issue are shown in the accompanying tables. The highest and lowest value for the vacuum that were observed are not given in the engravings, but an average is taken, as we have already signified, from which there was very little variation. In the diagrams on Plate I., published last month, and Plate II., found in this issue, the space between two adjacent abscissa points denotes a distance in actual practice of 1.57 inches, while the two adjacent points on the axis of ordinates denote a distance of .30 inches.

Experiments were made with two kinds of conical stacks, namely those with and without a reverse inclination. The first are called the waist stacks and the latter the funnel stacks in what follows. In the waist stacks the smallest diameter was located 17.52 inches above the bottom edge, while in the latter this smallest diameter was at the very bottom. All of the stacks had the same height of 5 feet 7.68 inches, as shown in Fig. 29 of our last issue. In order to have a definite arrangement for the comparison of the data obtained from the two forms of stack, the waist stack was placed with its smallest section at the same distance from the nozzle opening as was the smallest portion of the funnel stack, whence the nozzle was 17.52 inches above the bottom of the former when it was exactly flush with the bottom of the latter. Hence, upon all of the tables the same figures are given for the same abscissas indicative of the blast-nozzle distances.

The nozzle was held off 1.38 inches from the top of the air chamber of the apparatus. Hence, the shortest distance at which the nozzle could work in all of the experiments was 18.9 inches from the waist of the stack.

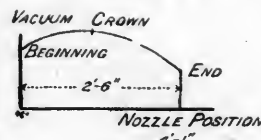
III.—EXPERIMENTS WITH FULL-LENGTH STACKS. CYLINDRICAL STACKS.

In plate I. the vacuum obtained with each of the five experimental stacks, with the five different positions of the blast nozzle, is given graphically. The vacuum obtained with each diameter of blast nozzle, with the five different smokestacks, is also shown. It appears, then, from these groups of curves that, other conditions being the same, the

vacuum increases as the stack is made smaller, and the distance to the nozzle increased. Both of these conditions, however, only hold good near the upper limits; for as the curves under (B) show, the difference in the vacuum produced by two consecutive stacks becomes less as the stacks are smaller. These variations are also different for different diameters of blast nozzle (the steam pressure remaining the same) and decrease as the distance to the nozzle increases.

TABLE II.
CYLINDRICAL STACKS.

Diameter of stack in inches.	Vacuum in inches of water with a nozzle diameter of				
	3.94 in.	4.33 in.	4.74 in.	5.12 in.	5.51 in.
13.78	Beginning..... 3.96	4.23	4.53	4.87	4.53
	Crown..... 4.04	4.29	4.59	4.81	4.53
	End..... 3.50	3.62	3.76	3.72	3.50
14.76	Beginning..... 3.70	4.04	4.37	4.45	4.45
	Crown..... 3.91	4.26	4.57	4.65	4.57
	End..... 3.50	3.82	4.02	4.06	3.80
15.75	Beginning..... 3.43	3.78	4.09	4.23	4.29
	Crown..... 3.74	4.06	4.37	4.51	4.45
	End..... 3.52	3.82	4.09	4.19	4.08
16.73	Beginning..... 3.11	3.45	3.78	4.33	4.04
	Crown..... 3.50	3.84	4.13	4.29	4.33
	End..... 3.13	3.72	4.02	4.13	4.11
17.72	Beginning..... 3.80	3.11	3.45	3.62	3.74
	Crown..... 3.25	3.56	3.90	4.06	4.09
	End..... 3.25	3.56	3.90	4.06	4.09



NOTE.—The crown or crest of the curve marks the highest vacuum produced.

Referring to Table II, which marks the three characteristic points of each curve, we find that the differences between the values given for the beginning of the curves, for a nozzle diameter of 3.94 inches (starting with the stack of greatest diameter) is 0.31 inch, 0.32 inch, 0.27 inch and 0.26 inch, and where the nozzle diameter is 5.51 inches, these differences are only 0.30 inch, 0.25 inch, 0.16 inch and 0.08 inch. For the first diameter of nozzle, therefore, the limit of diameter for the stack is about 9.84 inches, at which point the vacuum rises to the ratio laid down, the nozzle distance being 18.9 inches, which means that for a diameter smaller than this, the vacuum falls off. For a nozzle diameter of 5.51 inches, the smallest stack has a diameter of about 13.37 inches.

Those stacks giving the greatest indraft of air, as we have shown in the historical portion, have been mistaken by different investigators as being the most efficient, while in reality, they are entirely unsuited to locomotives with nozzles much smaller than those used on the apparatus, on account of the large size of the cinders carried through the tubes and the sparks that are thrown.

If, for a given diameter of nozzle we take the stack diameters as abscissas, and the corresponding vacuums produced as ordinates, we obtain a curve like that shown in Fig. 30, illustrating the rise and fall of the vacuum with the changing diameters of the stacks. We see that, in this case, the graphical representation cannot be taken as the sole indicator of the efficiency of the action of the stack.

The increase in the vacuum, with the increasing distance to the nozzle, naturally becomes greatest with the largest stack. This amounts, for example, to 0.45 inch for an increase of this distance from 18.9 inches to 4 feet 1 inch, and with nozzle diameters equal to 3.94 inches and 4.74 inches as indicated in Fig. 31, for the smallest diameter of nozzle this gives an increase of 16 per cent. This would have been still greater if experiments had been made with an original distance less than 18.9 inches. This last distance is really too great for a stack 13.78 inches in diameter, as the corresponding curve in Plate II. shows. These diagrams also show that the diameter of the cylindrical stacks must be from 3.7 to 3.8 times the diameter of the nozzle.

Near its highest point the curves are usually nearly straight, and then they begin, on account of the frictional losses, due to the contact of the current of steam against the stack, to take a sharper curvature, corresponding to the fall of the vacuum, and come down toward the axis of abscissas.

If we take for the abscissa of the highest point of the curve, the average values of five different nozzle openings, as given in Table II., the maximum vacuum for the stack is obtained:

With a diameter of 13.78 inches, with a nozzle distance of 1 foot, 10.72 inches, or 1.63 times the stack diameter; with a diameter of 14.65 inches, with a nozzle distance of 2 feet 4.35 inches, or 1.95 times the stack diameter; with a diameter of 15.75 inches, with a nozzle distance of 2 feet 9.54 inches, or 2.13 times the stack diameter; with a diameter of 16.73 inches, with a nozzle distance of 3 feet 0.22 inch or 2.16 times the stack diameter; with a diameter of 17.72 inches, with a nozzle distance of 3 feet 6.36 inches, or 2.39 times the stack diameter.

Therefore, we may take as an average for the distance of the nozzle, twice the diameter of the stack. But since the vacuum diminishes each way on the curve from the crest, it is best to make the nozzle distance less than the abscissa of the crest of the curve, or, in other words, the nozzle distance

should be made less than twice the diameter of the stack. As a practical rule and one which has been successfully applied to different locomotives, we may put the nozzle distance at from $1\frac{1}{2}$ to $1\frac{3}{4}$ times the stack diameter.

The maximum vacuum is produced if the total height of the stack is made from 4.6 to 4.7 times the stack diameter. This is clearly shown in Table III.

TABLE III.

Diameter of stacks in inches.	The maximum vacuum will be obtained if the distance from the nozzle to the top of the stack is equal to that given in inches below when the nozzle diameter is					The ratio of the total height of the stack to its diameter.
	3.94 in.	4.33 in.	4.74 in.	5.12 in.	5.51 in.	
13.78	5' 5.33"	5' 3.07"	5' 3.00"	5' 2.21"	4' 11.00"	4.5
14.76	5' 10.87"	5' 10.08"	5' 9.29"	5' 8.50"	5' 6.14"	4.6
15.75	6' 2.89"	6' 2.02"	6' 1.23"	6' 0.45"	5' 10.08"	4.6
16.73	6' 6.74"	6' 5.10"	6' 4.48"	6' 3.50"	6' 2.02"	4.6
17.72	6' 9.10"	6' 11.15"	7' 0.25"	6' 10.08"	6' 9.10"	4.7

From the foregoing we come to the following conclusion: With cylindrical stacks the total distance from the nozzle to the top of the stack should not be more than 4.7 times the diameter of the stack.

If Nozo and Geoffrey found the greatest draught to be created with a height of stack equal to from six to seven times its diameter, it was certainly due to the small dimensions of their experimental apparatus producing such variations as also caused them to declare that the nozzle should be located close to the lower end of the stack. (At that time it was common practice to place the nozzle flush with the latter.)

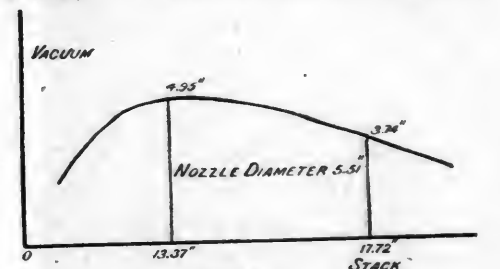


Fig. 30.

From the Hanover experiments, then, and in consequence of the greater distance at which the blast nozzle has been set, we at last come to the determination of the sectional area of the bell-shaped foot of the stack that is commonly used, and the influence, slight as it is, which this actual lessening of the length of the stack may have. This would undoubtedly have been somewhat greater if the cylindrical experimental stacks of from 13.78 inches to 16.73 inches in diameter, but with no flare at the bottom, had had a

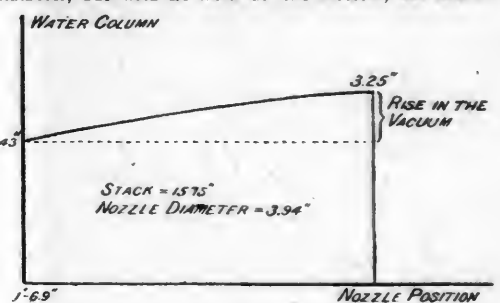


Fig. 31.

base 17.52 inches high, and like Fig. 32, had simply been provided with a smooth funnel-shaped base, as was the case with the stacks of 17.72 inches diameter. According to Section IV., we would have a length for the last-mentioned stack of from 4.8 to 5 times the diameter. But such a length is not susceptible of a practical application, since by the use of such a stack diameter, too high a vacuum and too strong a discharge of sparks would result. For ordinary purposes a length of from $3\frac{1}{2}$ to 4 times the diameter is sufficient,

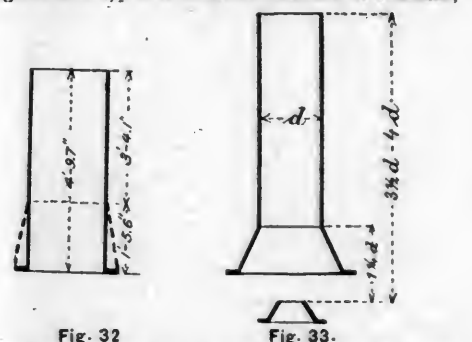


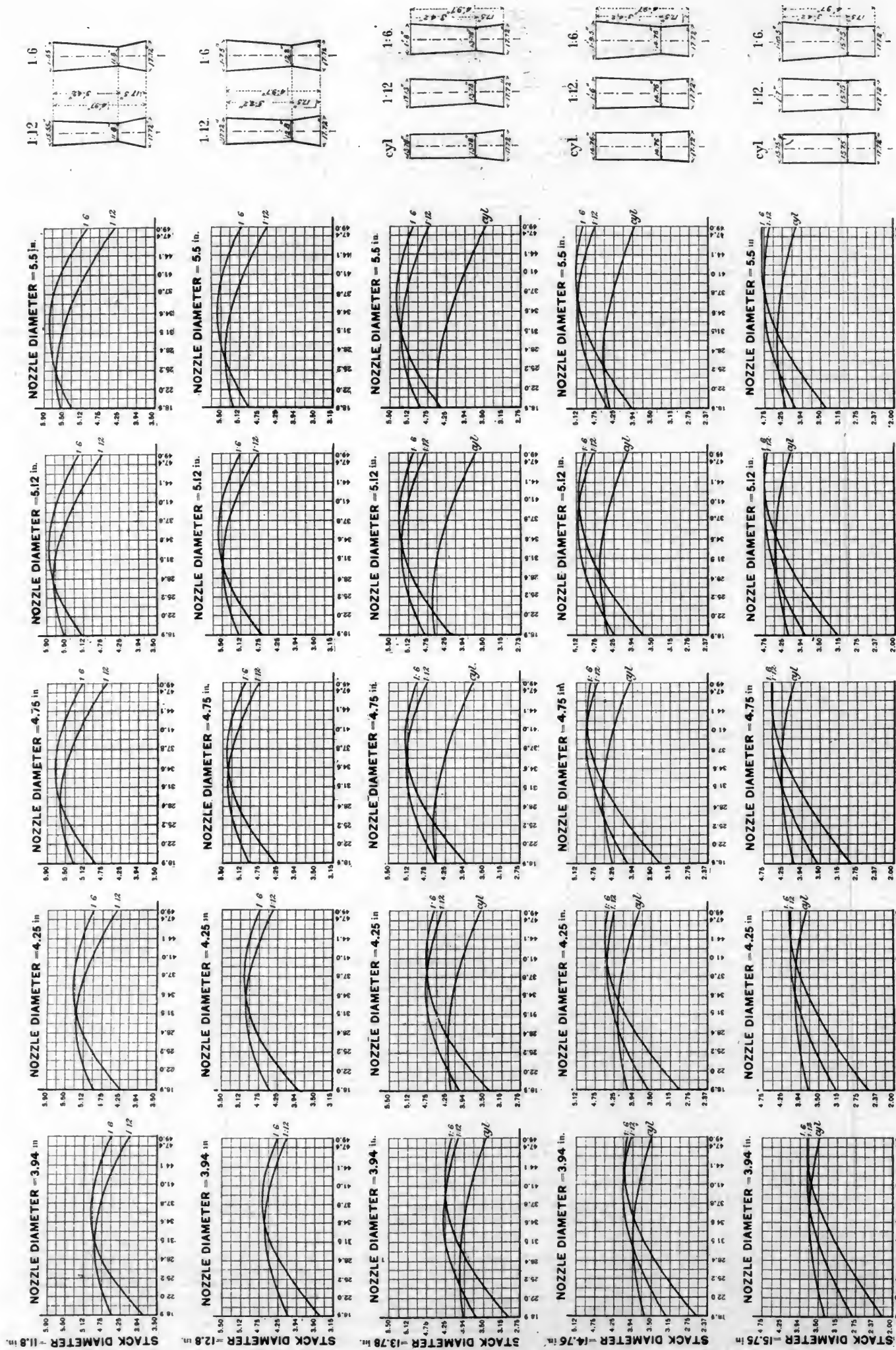
Fig. 32

Fig. 33.

whereby lower results for a large stack diameter (about 17.72 inches) would result. By referring to the average nozzle distances that have been given, the ratios shown in Fig. 33 may be taken as reliable, practical measurements.

(B) CONICAL STACKS.

What has just been said regarding cylindrical stacks can also be accepted as true, in a general way, for conical stacks. Except that it appears to be far more sensitive to the nozzle location, since the increase of vacuum with it for the same increase in nozzle location is evidently greater than with the cylindrical stack. This increase for an inch drop in the nozzle becomes more rapid the sharper the flare of the stack



NOTE 1. The abscissas give the distance of the top of the blast nozzle below the smallest diameter of the stack; the ordinates denote the corresponding vacuum in inches of water.
 2. The curves are plotted from an average of the values obtained, and they vary from the maxima and minima observed by from .08 to .06 inch.
 3. All of the observations were made with the same steam pressure (8.94 inches of mercury) and with the same opening for the admission of air.
 4. The figures at the right hand end of each curve are the diameters of the corresponding blast nozzle or stack.

PLATE II.—COMPARISON OF THE ACTION BY CYLINDRICAL AND CONICAL STACKS HANOVER EXPERIMENTS.

toward the top (of course within certain limits), as an examination of the curves under II. and III. in Plate I will show, where the curves under II. are very markedly flatter than under III. These results are here tabulated under Tables IV. and V., for convenient reference. Here we take for our example a stack having a maximum diameter of 15.75 inches and a nozzle diameter of 3.94 inches, the vacuum increasing with the increasing distance of the nozzle—for stacks having an inclination of $\frac{1}{2}$, the increase was about 0.96 inches, or 34 per cent., and with one having an inclination of $\frac{1}{4}$ it was 1.61 inch, or about 76 per cent.

TABLE IV.
CONICAL STACKS WITH AN INCLINATION OF $\frac{1}{2}$.

Stack Diameters in inches.	Vacuum in inches of water column with nozzle diameters of				
	3.94 in.	4.33 in.	4.74 in.	5.12 in.	5.51 in.
11.81 { Beginning.....	4.19	4.92	5.35	5.53	5.55
{ Crown.....	5.90	5.29	5.63	5.75	5.67
{ End.....	5.94	4.43	4.65	4.89	4.41
12.80 { Beginning.....	4.08	4.49	4.96	5.15	5.24
{ Crown.....	4.63	5.03	5.41	5.49	5.43
{ End.....	4.13	4.45	4.74	4.78	4.53
13.78 { Beginning.....	3.65	4.06	4.51	4.78	4.90
{ Crown.....	4.37	4.78	5.15	5.28	5.23
{ End.....	4.09	4.45	4.74	4.78	4.71
14.76 { Beginning.....	3.35	3.82	4.06	4.35	4.49
{ Crown.....	4.13	4.49	4.94	5.11	5.12
{ End.....	3.98	4.33	4.69	4.76	4.75
15.75 { Beginning.....	2.82	3.17	3.58	3.86	4.06
{ Crown.....	3.78	4.13	4.55	4.74	4.74
{ End.....	3.78	4.13	4.55	4.69	4.65

TABLE V.
CONICAL STACKS WITH AN INCLINATION OF $\frac{1}{4}$.

Stack diameters in inches.	Vacuum in inches of water column with nozzle diameters of				
	3.94 in.	4.33 in.	4.74 in.	5.12 in.	5.51 in.
11.81 { Beginning.....	3.84	4.31	4.88	5.15	5.32
{ Crown.....	4.98	5.35	5.73	5.87	5.80
{ End.....	4.53	4.93	5.15	5.19	5.02
12.80 { Beginning.....	3.13	3.66	4.37	4.69	4.92
{ Crown.....	4.65	5.06	5.41	5.59	5.59
{ End.....	4.35	4.74	5.06	5.12	5.10
13.78 { Beginning.....	3.02	3.41	3.88	4.21	4.45
{ Crown.....	4.33	4.77	5.15	5.32	5.36
{ End.....	4.21	4.61	4.96	5.06	5.06
14.76 { Beginning.....	2.68	2.95	3.37	3.70	3.96
{ Crown.....	4.12	4.53	4.92	5.10	5.14
{ End.....	4.08	4.47	4.86	4.98	5.02
15.75 { Beginning.....	2.15	2.48	2.85	3.17	3.41
{ Crown.....	3.78	4.15	4.57	4.74	4.80
{ End.....	3.78	4.15	4.57	4.74	4.80

With the same minimum sectional area, and starting with the same nozzle distances, the stack having an inclination of $\frac{1}{2}$ gives a higher vacuum than the stack with an inclination of $\frac{1}{4}$; but the latter creates the same draught if the distance to the nozzle is correspondingly increased. At the same time the two forms of stacks give the same maximum

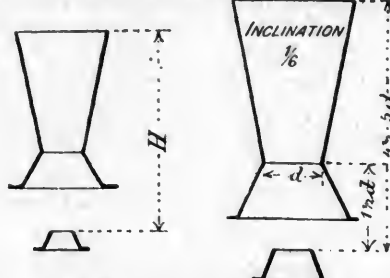


Fig. 34.

Fig. 35.

vacuum, it being understood, of course, that the nozzle distances are different.

Here also the curves run comparatively straight on either side of their crests. Now, if we take, as we have already done for the cylindrical stacks, the average values from Table VI. for the abscissas of the crown of the curves, we will find that the maximum vacuum will be obtained with a stack having an inclination of $\frac{1}{2}$ when its smallest diameter is:

- 11.81 inches and the nozzle distance is 2 feet 3.95 inches, which is 2.37 times the stack diameter;
- 12.80 inches and the nozzle distance is 2 feet 7.02 inches, which is 2.42 times the stack diameter;
- 13.78 inches and the nozzle distance is 2 feet 10.12 inches, which is 2.47 times the stack diameter;
- 14.76 inches and the nozzle distance is 3 feet 1.48 inches, which is 2.53 times the stack diameter;
- 15.75 inches and the nozzle distance is 3 feet 4.79 inches, which is 2.59 times the stack diameter.

So that for an average the nozzle distance may be taken to be 2.5 times the stack diameter.

With a stack having an inclination of this maximum vacuum will be obtained when its smallest diameter is: 11.81 inches and the nozzle distance is 2 feet 0.7 inches, which is 2.85 times the stack diameter; 12.80 inches and the nozzle distance is 3 feet 0.62 inches, which is 2.86 times the stack diameter; 13.78 inches and the nozzle distance is 3 feet 3.61 inches, which is 2.87 times the stack diameter; 14.76 inches and the nozzle distance is 3 feet 6.91 inches, which is 2.90 times the stack diameter;



Baldwin-Westinghouse Electric Locomotive.

15.75 inches and the nozzle distance is 3 feet 10.22 inches, which is 2.93 times the stack diameter. So that, for an average, the nozzle distance may be taken at 2.9 times the smallest diameter of the stack.

Now, since the sharp downward inclination of the curves begins at an earlier point on the crown with the conical stacks than it does with the cylindrical, so the maximum results will be obtained with far lower values than is possible with cylindrical stacks. It is, therefore, recommended that, with stacks having an inclination of $\frac{1}{2}$, the nozzle distance should not be more than twice the smallest diameter of the stack. According to observations made upon locomotives the following rule may be considered to prevail: A nozzle distance from $1\frac{1}{2}$ to 2 times the stack diameter is an effective one. This can also be applied to stacks of other inclinations.

The total height H , at which the strongest draught is obtained, is shown for both the $\frac{1}{2}$ and $\frac{1}{4}$ inclinations in Table VI. An examination of Table II. shows that the height H , Fig. 34, for the conical stack, is greater than that for the cylindrical stack, and that this increases as the opening of the stack at the top is greater.

This ratio relatively to the diameter may be taken to average as follows:

Cylindrical stack.....	4.6
Conical .. $\frac{1}{2}$ inclination.....	5.4
Conical .. $\frac{1}{4}$ inclination.....	5.8

Again, while this ratio increases with the increase of diameter of the cylindrical stack, it decreases with the conical stack as the inclination is increased.

The maximum heights of vacuum given in Tables III. and VI., taken roughly, are applicable only to stacks whose upper portion above the smallest sectional area is 3 feet, 4 inches long. If we make this latter distance greater, the total stack height falls still more, always, of course within certain limits.

From the applications given above and those given in Sections IV. and V., we can determine the maximum values of the ratios of the total height of the stack to the diameter, which may be stated, in round numbers, to be for:

Cylindrical stacks, about.....	5
Conical stacks with $\frac{1}{2}$ inclination, about.....	6
Conical stacks with $\frac{1}{4}$ inclination, about.....	6 $\frac{1}{2}$

Furthermore, these are not exact values, since those previously given are too great for actual service and for the same reasons as that assigned for the cylindrical stacks. We, therefore, reach the following conclusion:

When the waist diameter of the conical stack is carefully chosen, the total height should not be more than five times this diameter.

For a perfectly satisfactory construction, the ratios given in Fig. 35 will be found to yield effective dimensions. But when the diameter is 14.17 inches or more, we must use the smaller dimension ($4\frac{1}{2}d$).

(To be Continued.)

The New Baldwin-Westinghouse Electric Locomotives.

The Westinghouse Electric and Manufacturing Company has received the first electric locomotive manufactured under the arrangement entered into some time ago between Westinghouse and the Company and the Baldwin Locomotive Works of Philadelphia. It is shown in the accompanying engraving, from which it will be seen to be a radical departure in construction from any electric locomotive hitherto manufactured. It is 88 feet long and 9 feet wide over all. All the operating parts of the locomotive have been placed on the trucks and the body of the car will only contain the controlling apparatus, and can be utilized as a receptacle for such appliances as are usually carried by

any train. It may also be used as a freight or baggage car.

It is carried on four pairs of wheels arranged in two trucks that are constructed in a very substantial manner. The wheels are 42 inches in diameter. There will be four motors of 250 horse-power, each connected to an axle of the locomotive. Thus the entire weight of the locomotive will be available for adhesion. The locomotive completely equipped weighs 160,000 pounds. The motors are geared, which method was decided upon so as to enable the company to use more efficient and durable motors, and also to greatly reduce the cost of the locomotive. It is stated that while the electric locomotive used in the Baltimore tunnel cost about \$50,000, the Baldwin-Westinghouse locomotive cost less than one-third of that amount, and yet it will be able to accomplish the same work. Locomotives will be manufactured for tunnel work, suburban traffic and rack locomotives, as well as for elevated railroads. By the time this paper reaches our readers the second locomotive completed by the Baldwin people will be received at the East Pittsburgh factory of the Westinghouse Electric and Manufacturing Company. This last one will be of the elevated railroad type, and is an example of a motor car of the Manhattan Elevated Railroad of New York.

As far as the speed of the new locomotive we illustrate is concerned, it may be stated that the motors have been geared to produce a speed of 75 miles an hour. The locomotive is equipped with air-brakes, which are operated in the usual manner, and are supplied with air by a pump underneath the car driven by an electric motor.

The locomotive has been designed so as to be utilized with any method of electric traction. It can be used with the trolley system, the third rail system, the Westinghouse electro-magnetic system, and can also be utilized in connection with the Tesla polyphase system.

Since it has become known that the Baldwin-Westinghouse companies are constructing electric locomotives, enquiries have come from all over the world for such machines, indicating the wonderful demand there is for such engines when manufactured by well known and reliable firms.

Centrifugal Sand-Mixing Machine.

The firm of William Sellers & Company, Incorporated, Philadelphia, has recently brought out a simple and effective sand-mixing machine, that has resulted in a great saving of labor wherever used, besides more thoroughly mixing the sand for the mold. At a recent meeting of the Foundrymen's Association, Mr. A. E. Outerbridge read a paper on



Fig. 1.—Sand Mixing Machine.

molding sand in which he described the machine, and the following quotations from his paper state the conditions which led up to its introduction:

"Whatever special proportions of sand are used in foundries the same necessity exists in all for thoroughly mixing the old and new materials, and until comparatively recently the old methods of riddling and spading were adhered to. A

TABLE VI.

Diameter of stack in inches.	The highest vacuum is obtained when the total height of the stack measuring from the nozzle to the top of the stack is equal in inches to the figures given below, when the nozzle diameter is:										The average ratio of the total height of the stack to the diameter of the same.											
	3.91 inches.		4.33 inches.		4.74 inches.		5.12 inches.		5.51 inches.													
	Inclination $\frac{1}{2}$.	Inclination $\frac{1}{4}$.	Inclination $\frac{1}{2}$.	Inclination $\frac{1}{4}$.	Inclination $\frac{1}{2}$.	Inclination $\frac{1}{4}$.	Inclination $\frac{1}{2}$.	Inclination $\frac{1}{4}$.	Inclination $\frac{1}{2}$.	Inclination $\frac{1}{4}$.												
11.81.....	Ft. 5.	In. 10.08	Ft. 6.	In. 4.48	Ft. 5.	In. 9.69	Ft. 6.	In. 3.59	Ft. 5.	In. 8.50	Ft. 6.	In. 2.02	Ft. 5.	In. 7.72	Ft. 6.	In. 0.45	Ft. 5.	In. 4.57	Ft. 5.	In. 10.87	5.77	6.25
12.80.....	6	1.23	6	6.34	6	0.84	6	6.595	5	11.66	6	9.10	6	2.41	6	3.49	5	7.72	6	2.80	5.53	6.01
13.78.....	6	4.48	6	9.50	6	3.49	6	9.11	6	2.86	6	8.31	6	1.23	6	6.74	5	10.87	6	5.16	5.38	5.78
14.76.....	6	7.53	7	0.65	6	6.74	7	0.26	6	6.34	6	7.53	6	4.77	6	9.30	6	2.80	6	9.10	5.63	5.63
15.75.....	6	9.89	7	4.19	6	10.68	7	3.80	6	9.11	7	2.62	6	8.31	7	1.04	6	6.74	7	0.36	5.14	5.48

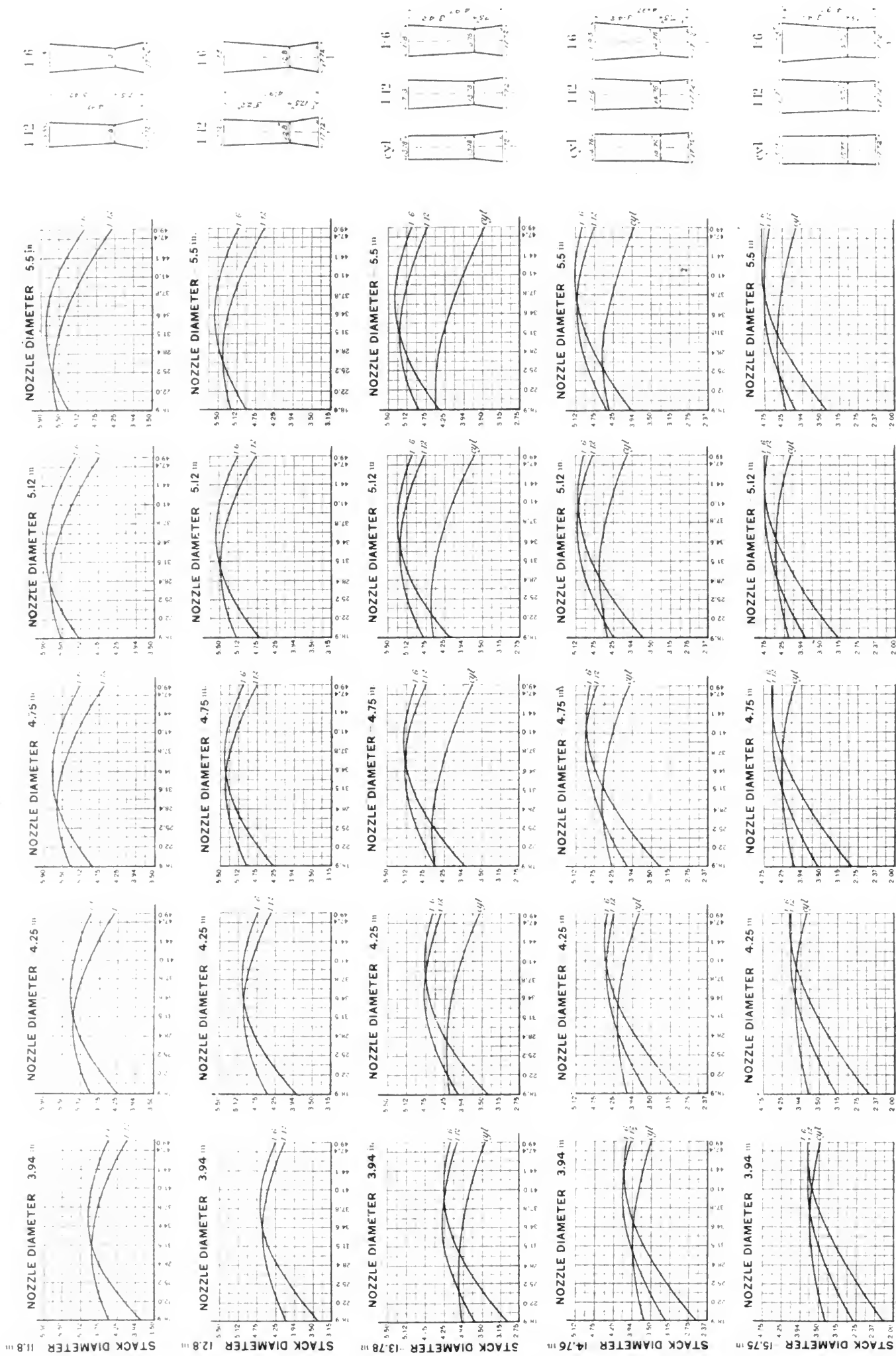


PLATE II.—COMPARISON OF THE ACTION BY CYLINDRICAL AND CONICAL STACKS (HANGER EXPERIMENTS.)

NOTE: 1. The abscissas give the distance of the top of the blast nozzle below the smallest diameter of the stack; the ordinates denote the corresponding vacuum in inches of water.
 2. The curves are plotted from an average of the values obtained, and they vary from the maxima and minima observed by from .02 to .08 inch.
 3. All of the observations were made with the same steam pressure (8.94 inches of mercury) and with the same opening for the admission of air.
 4. The figures at the right hand end of each curve are the diameters of the corresponding blast nozzle or stack.

toward the top (of course within certain limits), as an examination of the curves under II. and III. in Plate I will show, where the curves under II. are very markedly flatter than under III. These results are here tabulated under Tables IV. and V., for convenient reference. Here we take for our example a stack having a maximum diameter of 15.75 inches and a nozzle diameter of 3.94 inches, the vacuum increasing with the increasing distance of the nozzle—for stacks having an inclination of $\frac{1}{2}$, the increase was about 0.90 inches, or 31 per cent., and with one having an inclination of $\frac{1}{3}$ it was 1.61 inch, or about 76 per cent.

TABLE IV.
CONICAL STACKS WITH AN INCLINATION OF $\frac{1}{2}$.

Stack Diameters in inches.	Vacuum in inches of water column with nozzle diameters of				
	3.94 in.	4.33 in.	4.71 in.	5.12 in.	5.51 in.
11.81	Beginning..... 4.49	4.92	5.35	5.73	5.55
	Crown..... 5.90	5.29	5.63	5.75	5.67
	End..... 3.94	4.43	4.65	4.89	4.41
12.80	Beginning..... 4.08	4.49	4.91	5.15	5.24
	Crown..... 4.63	5.03	5.41	5.49	5.43
	End..... 4.13	4.45	4.74	4.78	4.53
13.78	Beginning..... 3.95	4.06	4.51	4.78	4.90
	Crown..... 4.37	4.78	5.15	5.28	5.28
	End..... 4.00	4.45	4.71	4.78	4.71
14.76	Beginning..... 3.25	3.62	4.06	4.33	4.49
	Crown..... 4.13	4.49	4.94	5.11	5.12
	End..... 3.98	4.33	4.69	4.76	4.75
15.75	Beginning..... 2.82	3.17	3.58	3.86	4.06
	Crown..... 3.78	4.13	4.55	4.74	4.74
	End..... 3.78	4.13	4.55	4.69	4.65

TABLE V.
CONICAL STACKS WITH AN INCLINATION OF $\frac{1}{3}$.

Stack diameters in inches.	Vacuum in inches of water column with nozzle diameters of				
	3.94 in.	4.33 in.	4.71 in.	5.12 in.	5.51 in.
11.81	Beginning..... 2.81	4.31	4.88	5.15	5.32
	Crown..... 4.98	5.35	5.73	5.87	5.80
	End..... 1.53	4.33	5.15	5.19	5.02
12.80	Beginning..... 3.43	3.86	4.37	4.69	4.92
	Crown..... 4.55	5.06	5.41	5.59	5.59
	End..... 4.55	4.74	5.06	5.12	5.10
13.78	Beginning..... 3.02	3.41	3.88	4.21	4.45
	Crown..... 4.33	4.77	5.15	5.32	5.36
	End..... 4.21	4.61	4.96	5.06	5.06
14.76	Beginning..... 2.38	2.93	3.37	3.70	3.96
	Crown..... 4.12	4.53	4.92	5.10	5.14
	End..... 4.08	4.47	4.86	4.98	5.02
15.75	Beginning..... 2.15	2.48	2.85	3.17	3.41
	Crown..... 3.78	4.15	4.57	4.74	4.80
	End..... 3.78	4.15	4.57	4.74	4.80

With the same minimum sectional area, and starting with the same nozzle distances, the stack having an inclination of $\frac{1}{2}$ gives a higher vacuum than the stack with an inclination of $\frac{1}{3}$; but the latter creates the same draught if the distance to the nozzle is correspondingly increased. At the same time the two forms of stacks give the same maximum

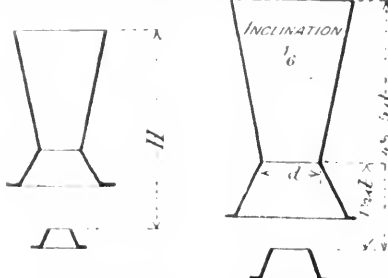


Fig. 34.

Fig. 35.

vacuum, it being understood, of course, that the nozzle distances are different.

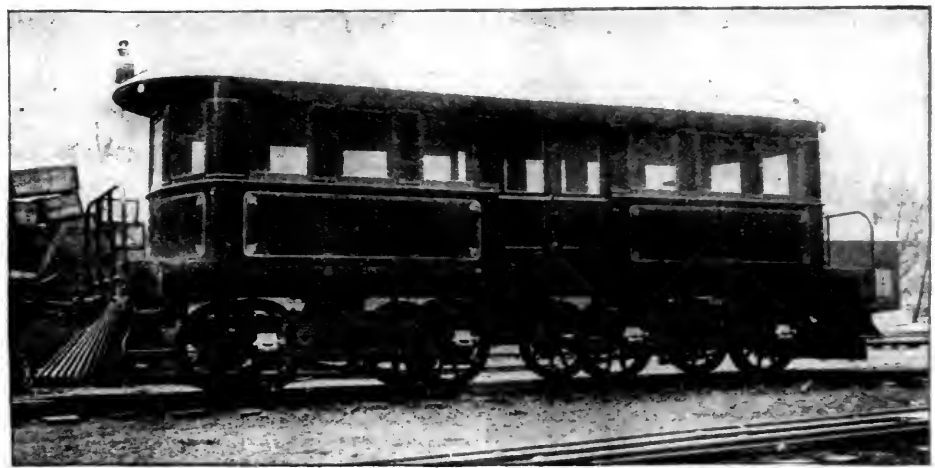
Here also the curves run comparatively straight on either side of their crests. Now, if we take, as we have already done for the cylindrical stacks, the average values from Table VI. for the abscissas of the crown of the curves, we will find that the maximum vacuum will be obtained with a stack having an inclination of $\frac{1}{2}$ when its smallest diameter is:

- 11.81 inches and the nozzle distance is 2 feet 3.95 inches, which is 2.37 times the stack diameter;
- 12.80 inches and the nozzle distance is 2 feet 7.02 inches, which is 2.42 times the stack diameter;
- 13.78 inches and the nozzle distance is 2 feet 10.12 inches, which is 2.47 times the stack diameter;
- 14.76 inches and the nozzle distance is 3 feet 1.48 inches, which is 2.53 times the stack diameter;
- 15.75 inches and the nozzle distance is 3 feet 1.79 inches, which is 2.59 times the stack diameter.

So that for an average the nozzle distance may be taken to be 2.5 times the stack diameter.

With a stack having an inclination of this maximum vacuum will be obtained when its smallest diameter is:

- 11.81 inches and the nozzle distance is 2 feet 9.7 inches, which is 2.85 times the stack diameter;
- 12.80 inches and the nozzle distance is 3 feet 0.62 inches, which is 2.86 times the stack diameter;
- 13.78 inches and the nozzle distance is 3 feet 3.61 inches, which is 2.87 times the stack diameter;
- 14.76 inches and the nozzle distance is 3 feet 6.91 inches, which is 2.90 times the stack diameter;



Baldwin-Westinghouse Electric Locomotive.

15.75 inches and the nozzle distance is 3 feet 10.22 inches, which is 2.93 times the stack diameter.

So that, for an average, the nozzle distance may be taken at 2.9 times the smallest diameter of the stack.

Now, since the sharp downward inclination of the curves begins at an earlier point on the crown with the conical stacks than it does with the cylindrical, so the maximum results will be obtained with far lower values than is possible with cylindrical stacks. It is, therefore, recommended that, with stacks having an inclination of $\frac{1}{2}$, the nozzle distance should not be more than twice the smallest diameter of the stack. According to observations made upon locomotives the following rule may be considered to prevail: 1 nozzle distance from $1\frac{1}{2}$ to 2 times the stack diameter is an effective one. This can also be applied to stacks of other inclinations.

The total height H , at which the strongest draught is obtained, is shown for both the $\frac{1}{2}$ and $\frac{1}{3}$ inclinations in Table VI. An examination of Table II. shows that the height H , Fig. 31, for the conical stack, is greater than that for the cylindrical stack, and that this increases as the opening of the stack at the top is greater.

This ratio relatively to the diameter may be taken to average as follows:

Cylindrical stack, about.....	4.6
Conical stack with $\frac{1}{2}$ inclination, about.....	5.4
Conical stack with $\frac{1}{3}$ inclination, about.....	5.8

Again, while this ratio increases with the increase of diameter of the cylindrical stack, it decreases with the conical stack as the inclination is increased.

The maximum heights of vacuum given in Tables III. and VI., taken roughly, are applicable only to stacks whose upper portion above the smallest sectional area is 3 feet, 4 inches long. If we make this latter distance greater, the total stack height falls still more, always, of course within certain limits.

From the applications given above and those given in Sections IV. and V., we can determine the maximum values of the ratios of the total height of the stack to the diameter, which may be stated, in round numbers, to be for:

Cylindrical stacks, about.....	5
Conical stacks with $\frac{1}{2}$ inclination, about.....	6
Conical stacks with $\frac{1}{3}$ inclination, about.....	6.5

Furthermore, these are not exact values, since those previously given are too great for actual service and for the same reasons as that assigned for the cylindrical stacks. We, therefore, reach the following conclusion:

When the waist diameter of the conical stack is carefully chosen, the total height should not be more than five times this diameter.

For a perfectly satisfactory construction, the ratios given in Fig. 35 will be found to yield effective dimensions. But when the diameter is 11.17 inches or more, we must use the smaller dimension ($1\frac{1}{2}d$).

(To be Continued.)

The New Baldwin-Westinghouse Electric Locomotives.

The Westinghouse Electric and Manufacturing Company has received the first electric locomotive manufactured under the arrangement entered into some time ago between Westinghouse the Company and the Baldwin Locomotive Works of Philadelphia. It is shown in the accompanying engraving, from which it will be seen to be a radical departure in construction from any electric locomotive hitherto manufactured. It is 38 feet long and 9 feet wide over all. All the operating parts of the locomotive have been placed on the trucks and the body of the car will only contain the controlling apparatus, and can be utilized as a receptacle for such appliances as are usually carried by

any train. It may also be used as a freight or baggage car.

It is carried on four pairs of wheels arranged in two trucks that are constructed in a very substantial manner. The wheels are 42 inches in diameter. There will be four motors of 250 horse-power, each connected to an axle of the locomotive. Thus the entire weight of the locomotive will be available for adhesion. The locomotive completely equipped weighs 160,000 pounds. The motors are geared, which method was decided upon so as to enable the company to use more efficient and durable motors, and also to greatly reduce the cost of the locomotive. It is stated that while the electric locomotive used in the Baltimore tunnel cost about \$50,000, the Baldwin-Westinghouse locomotive cost less than one-third of that amount, and yet it will be able to accomplish the same work. Locomotives will be manufactured for tunnel work, suburban traffic and rack locomotives, as well as for elevated railroads. By the time this paper reaches our readers the second locomotive completed by the Baldwin people will be received at the East Pittsburgh factory of the Westinghouse Electric and Manufacturing Company. This last one will be of the elevated railroad type, and is an example of a motor car of the Manhattan Elevated Railroad of New York.

As far as the speed of the new locomotive we illustrate is concerned, it may be stated that the motors have been geared to produce a speed of 15 miles an hour. The locomotive is equipped with air-brakes, which are operated in the usual manner, and are supplied with air by a pump underneath the car driven by an electric motor.

The locomotive has been designed so as to be utilized with any method of electric traction. It can be used with the trolley system, the third rail system, the Westinghouse electro-magnetic system, and can also be utilized in connection with the Tesla polyphase system.

Since it has become known that the Baldwin-Westinghouse companies are constructing electric locomotives, enquiries have come from all over the world for such machines, indicating the wonderful demand there is for such engines when manufactured by well known and reliable firms.

Centrifugal Sand-Mixing Machine.

The firm of William Sellers & Company, Incorporated, Philadelphia, has recently brought out a simple and effective sand-mixing machine, that has resulted in a great saving of labor wherever used, besides more thoroughly mixing the sand for the molder. At a recent meeting of the Foundrymen's Association, Mr. A. E. Osterbridge read a paper on

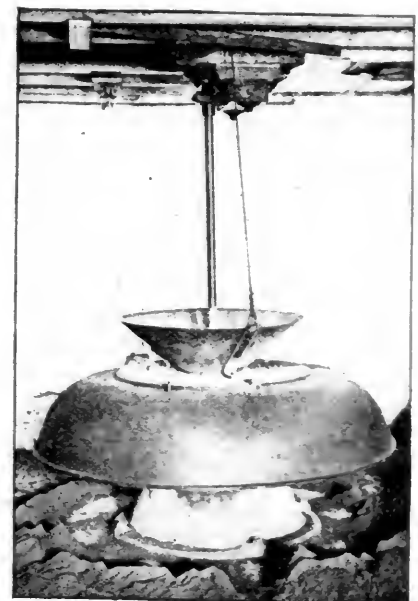


Fig. 1.—Sand Mixing Machine.

molding sand in which he described the machine, and the following quotations from his paper state the conditions which led up to its introduction:

"Whatever special proportions of sand are used in foundries the same necessity exists in all for thoroughly mixing the old and new materials, and until comparatively recently the old methods of riddling and swarding were adhered to. A

TABLE VI.

Diameter of stack in inches.	The highest vacuum is obtained when the total height of the stack measuring from the nozzle to the top of the stack is equal in inches to the figures given below, when the nozzle diameter is:										The average ratio of the total height of the stack to the diameter of the same.	
	3.94 inches.		4.33 inches.		4.71 inches.		5.12 inches.		5.51 inches.		Inclination $\frac{1}{2}$.	Inclination $\frac{1}{3}$.
	Inclination $\frac{1}{2}$.	Inclination $\frac{1}{3}$.	Inclination $\frac{1}{2}$.	Inclination $\frac{1}{3}$.	Inclination $\frac{1}{2}$.	Inclination $\frac{1}{3}$.	Inclination $\frac{1}{2}$.	Inclination $\frac{1}{3}$.	Inclination $\frac{1}{2}$.	Inclination $\frac{1}{3}$.		
11.81	5	10.08	6	1.48	5	9.69	6	3.59	5	8.56	5.77	6.25
12.80	6	1.23	6	6.31	6	0.81	6	5.95	5	11.66	5.53	6.01
13.78	6	1.18	6	9.50	6	3.19	6	9.10	6	2.86	5.38	5.78
14.76	6	7.53	7	0.65	6	6.74	7	0.26	6	6.34	5.26	5.62
15.75	6	9.89	7	4.19	6	10.68	7	3.89	6	9.11	5.11	5.48

few years ago the firm of William Sellers & Company began experimenting upon the preparation of molding and core sand by the aid of centrifugal force. The first machine was a comparatively crude affair, but when the correctness of the principle was demonstrated the apparatus was remodeled and greatly improved. This now thorough, practical and simple machine attracted the attention of visitors at various times and duplicates were made at the solicitation of the representatives of several of the largest establishments in Philadelphia. These little machines then created for themselves a reputation, which was followed by a demand for more of them, and the apparatus illustrated herewith is now regularly manufactured by the Sellers company for sale.

"The machine is remarkable, both as a labor saver and as an improver of molding sand. It accomplishes as much work by the helping of two laborers working three hours a

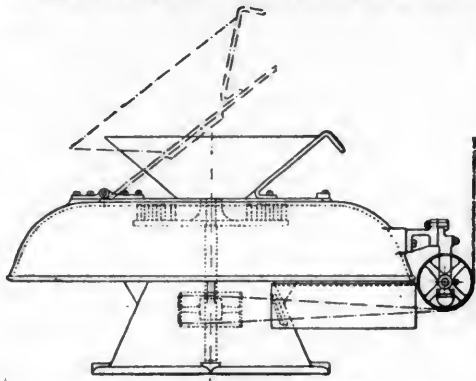


Fig. 2.—Sand Mixing Machine:

day in preparing facing sand as five men could do in 10 hours by the old method, and it is found that as the sand is much more uniformly mixed and tempered, its quality of toughness (without impairment of porosity) is decidedly improved.

The apparatus consists of a rapidly revolving table, having upon its upper surface a number of prongs grouped about a central axis. The sand is fed through a hopper and thrown with great force from prong to prong, emerging from beneath the cover in a fine shower, free from lumps and thoroughly mixed. The hopper is hinged for convenience of cleaning the revolving plate and prongs, and for removing stones, nails, etc. Our illustrations show an exterior view in Fig. 1 and Fig. 2 give the construction. The revolving table is carried on a vertical shaft which may be extended upward and driven from above by a belt, or if more convenient it may be belted from below as in Fig. 2. It is also adapted to be driven by an electric motor. Old sand which has been used in the foundry always contains nails, jaggers, iron scrap, etc., and new sand sometimes contains stones and other foreign substances. Such materials should be removed by the screen before the sand is passed through the machine. Ordinarily good molding sand needs no prior sieving, but is shoveled while damp directly into the hopper. The batches of "facing" and "core" sand are similarly treated. The sand falls upon the rapidly revolving plate, and is thrown with great force from one set of prongs to another, and then emerges from beneath the cover, more thoroughly mixed and better adapted for the molder's use than any amount of hand mixing could have made it.

Mr. J. S. Mundy, of Newark, N. J., the hoisting engine builder, has a contract for the New York Central & Hudson River Railroad for building the new drawbridge engine for the Spuyten Duyvil Creek draw. This drawbridge has a span of 200 feet. The engine has double cylinders with reverse link motion and by means of gearing operates two lines of steel shafts, 4½ inches in diameter, for opening and closing the draw. The engine is specially arranged for operating their temporary lift draw that is now in use across the Spuyten Duyvil Creek, and as soon as the permanent drawbridge is erected, will be transferred to the new draw. All the material entering into the construction of this engine is of the highest grade and workmanship of the very best.

That the product of the Westinghouse Electric and Manufacturing Company is of world-wide demand has again been demonstrated recently by the company receiving orders to equip an electric railway in the Isle of Man; another order for electric railway apparatus for the city of Coventry, England; and a third order for electric motors and railway generators for Cape Town, South Africa. The company is also about to ship an order for electric railway apparatus to Bangkok, Siam, India. The company is constantly constructing notable machinery for this country also. It recently shipped two of the largest electrical generators for the operation of an electric railway that have ever been turned out anywhere. These two machines are of 1,500 horse power each, and they were contracted for by the Nassau Electric Railway Company, of Brooklyn, N. Y.

The Chicago Tire and Spring Company announces that the business heretofore conducted by that company will hereafter be carried on by the Latrobe Steel Company, which has purchased the former company's plant at Meirose Park, Ill.

Superintendents of motive power and master mechanics will be interested to learn of a compound which is an absolute and permanent rust preventive for all bright parts of locomotives, tools and machinery. Mannocitin, made by Müller & Mann, Berlin, Germany, is such an article, and the fact that it has been adopted by the German Government railways and the leading iron and steel works will go to show that it has a great deal of merit. Mannocitin is composed of greases and volatile oils, leaving a thin, transparent film on the metal, which makes the latter impervious to weather and water and even fumes of muriatic acid and ammonia. The Mannocitin coating is entirely neutral, is not rubbed off in handling but can be quickly removed with turpentine or petroleum.

The same manufacturers also make excellent "rust proof paints," which railways abroad use largely for painting car trucks, roofs and iron structures, and which will interest the master car painter of every railroad.

Mannocitin, as well as Müller & Mann's rust proof paints are being introduced into this country by Otto Goetze 15 Whitehall St., N. Y., who will be pleased to send particulars and free samples to any of our readers on application.

The Abbott Machine Company, of Chicago Heights, Ill., have sold their plant to the Q & C Company, of Chicago, of which W. L. Findlay is President, and Charles F. Quincy, Treasurer. The Abbott company manufacture a check perforator, coin scales and other light machinery. These goods will now be made by the Q & C Company by contract. Additions will be made to the factory, the additions being larger than the old plant, and a foundry will also be built, so as to accommodate the work formerly done at the Q & C Company's shops at 2,634 Shields Avenue, Chicago.

The orders for the Leach sanding apparatus for locomotives have amounted to nearly 100 per month for some time past. In January of this year the orders received were for 113 sets, which is the largest month's business thus far experienced with this ingenious device. There are nearly 2,500 locomotives now equipped with them. Those who have given the matter no particular attention should write Mr. H. L. Leach, 176 Huron Avenue, North Cambridge, Mass., asking how much saving there is in the use of these sanders.

The Interchangeable Brake Beam Company, of St. Louis, have placed on the market a new metal beam that is to be known as the "Interchangeable." The compression member is of steel in tubular form and the tension member is a round rod. The heads are of malleable iron and are alike for both ends of the beam, there being no rights and lefts. The strut is in two pieces so put together that they are practically one when the truss rod is in place, but by loosening the latter one of the parts can be turned so as to reverse the angle of the slot for the brake lever. A rigid strut is employed if the purchaser prefers it. A recent test of the beam by Professor Johnson, of Washington University, gave the following result:

Diameter of back strut, 2.41 inches.	
Diameter of its rod, 1.00 inch.	
Weight of back strut, 30 pounds, 13 ounces.	
Applied loads at center.	Deflections at center.
Total pounds.	Inches.
2,000	0.012
4,000	0.020
6,000	0.030
7,500	0.049
8,000	0.052
10,000	0.069
12,000	0.085
15,000	0.097
18,000	0.017
20,000	0.214
21,720	0.349
27,660	...

The beam broke at 27,660 pounds through failure of the tie rod, which broke in the threads. The strut did not fail. The deflection of the brake beam, as indicated above, was only 0.049 inches for a load of 7,500 pounds, or 20 per cent. less than the allowable deflection, which is ½ inch.

Mr. Clarence S. Bement, of Bement, Miles & Company, Philadelphia, has recently been honored by the Royal Academy of Sciences, at Munich, Germany, which awarded him the silver medal, "Bene Merenti," for his services in the field of mineralogy. Though a busy man, Mr. Bement has found time to bring together a fine collection of minerals, and to do much to advance this science in which he is so greatly interested.

The Chicago Pneumatic Tool Company, 1553 Monadnock Block, Chicago, Ill., received last month another order from London for 10 of their pneumatic hammers, of the size used for flue heading and boiler calking.

Business is good with Messrs. W. A. Crook & Brothers Company, Newark, N. J., the prominent builders of high-grade hoisting machinery, and they have just established a branch office at Boston, Mass., corner of Franklin and Pearl streets, to accommodate the increased business from that section. In addition to their large line of hoisting engines for building, pile driving and general contractors' use, W. A. Crook & Brothers Company build improved hoists for mining and other hoisting purposes, which operate by electricity, and which have become extremely popular.

The Clayton Air Compressor Works, Havemeyer Building, New York, report recent sale of a large duplex steam actuated air compressor of their latest improved pattern to the Pennsylvania Railroad Company for the various applications of this power in their Altoona shops. This company has orders for several large compressors from other railroad companies for their shop uses of compressed air, and are also doing a large business in smaller compressors for testing and inflating hose and bicycle tires and for supplying crude oil burners.

The Standard Boiler Company, of Chicago, report a good business during the past year. They have moved into their new offices, 1120 and 1121 Marquette Building. The "Standard" boilers are built by the well-known firm, The Link-Belt Machinery Company, of Chicago, who have put in new and improved machinery for their manufacture, reducing their first cost as well as making the various parts interchangeable. During the past year a number of fine plants have been installed, among others being 4,000 horse-power for the North Chicago Street Railroad Company, at their new power station at Hawthorn Avenue; 800 horse-power for the Cincinnati Edison Company, of Cincinnati, O.; 800 horse-power for the Western Electric Company at their factory in Chicago, and various others. The prospects are good for the year 1896.

Geo. S. Fowler, of Fort Wayne, Ind., who has a large acquaintance among the railroad trade, has accepted a position under the new management of the Kalamazoo Railroad Velocipede and Car Company as their traveling sales agent. This company has been doing business for the last 13 years as a co-partnership, but was incorporated

Feb. 5, Mr. G. W. Miller retiring. The new officers are as follows: H. C. Reed, President; E. S. Roos, Vice-President; H. G. Haines, General Manager, Secretary and Treasurer. Mr. Reed, the new President, is a capitalist having large interests in various manufacturing enterprises in Kalamazoo. The new management proposes to enlarge and increase its facilities for manufacturing, and to furnish goods of unexcelled quality in its line so as to merit increased confidence and continued orders. The company shipped last month one each of their No. 9 "Special" steam inspection cars and 2 horse-power gasoline motor cars to Australia. They also shipped recently one 8 horse-power gasoline motor car to Mississippi, and one No. 9 "Special" steam inspection car to Buenos Ayres, South America.

From New York to Florida.

FLORIDA can be reached by the New York & Florida Short Line Limited. A train of Pullman's most modern build, elegantly appointed, and has all requirements of first-class travel, a compartment, observation, library, dining and sleeping car, and is operated solid between New York and St. Augustine, carrying Pullman drawing-room sleeping cars from New York to Augusta and Tampa. Asheville, Nature's Sanitarium, located in the mountains of western North Carolina, is reached in twenty-two hours from New York, via the Southern Railway, in Pullman drawing-room sleeping cars.

Our Directory

OF OFFICIAL CHANGES IN FEBRUARY.

We note the following changes of officers since our last issue. Information relative to such changes is solicited.

Atchison, Topeka & Santa Fe.—Mr. J. Foster has been appointed Master Mechanic at La Junta, Colo., vice Mr. I. Conroe.

Baltimore & Ohio.—John K. Cowen has been chosen President to succeed Mr. C. F. Meyer; Mr. Oscar G. Murray appointed First Vice-President, to succeed Mr. Orlando Smith, resigned. Second Vice-President T. M. King has resigned.

Baltimore & Ohio Southwestern.—Mr. T. M. King has been elected President.

Beech Creek.—George Thompson has been appointed Master Mechanic, with headquarters at Jersey Shore, Pa.

Boston & Albany.—Mr. F. D. Adams has resigned the position of Master Car Builder.

Buffalo & Susquehanna.—Master Mechanic J. D. Campbell has resigned, to take effect when his successor has been appointed.

Canadian Pacific.—Mr. R. Atkinson, who has been Acting Mechanical Superintendent, has been given the title of Mechanical Superintendent.

Central of Georgia.—Mr. H. M. Comer has been elected President of the road.

Chester & Lenoir.—Mr. G. W. F. Harper, President, has been appointed Receiver.

Chicago & Grand Trunk.—C. M. Hays, by virtue of his appointment as General Manager of the Grand Trunk, becomes President of the Chicago & Grand Trunk. Mr. W. J. Spicer, General Manager of this and other Grand Trunk properties west of the Detroit River, has resigned, and the duties of the office will be performed by the Manager of the Grand Trunk at Montreal.

Chicago Great Western.—Mr. A. D. Ward has been appointed Purchasing Agent, with headquarters at St. Paul, Minn., vice Mr. J. Warwick, resigned.

Cleveland, Cincinnati, Chicago & St. Louis.—Second Vice President Oscar G. Murray has resigned.

Delaware & Hudson Canal.—John H. Orchard has been appointed Master Car Builder of the Pennsylvania Division and the Gravity Railroad, with headquarters at Carbondale, Pa., vice Thomas Orchard, deceased.

Denver & Rio Grande.—Mr. T. R. Foster, formerly on the Chicago, Burlington & Quincy Railroad, at Galesburg, has accepted the position of Mechanical Engineer on the Denver & Rio Grande, at Denver, Colo.

Duluth, Missabe & Northern.—General Manager D. M. Philbin has resigned.

Hannibal & St. Joseph.—N. J. Paradise, Master Mechanic at Hannibal, died Jan. 27. He was also Master Mechanic of the St. Louis, Keokuk & Northwestern.

Hot Springs.—President E. M. Dickey has resigned.

Houston, East & West Texas.—President E. S. Jamison died last month.

Kansas City, Pittsburg & Gulf.—Mr. T. C. Sherwood has been appointed General Manager, with office at Kansas City, Mo.

Michigan & Pacific.—The office of general manager has been abolished.

New York Central & Hudson River.—Mr. E. C. Hiser, Master Mechanic at Utica, has resigned.

New York, Lake Erie & Western.—Mr. George Donahue, formerly Master Mechanic at Cleveland, has been transferred to Meadville, Pa. Mr. Willard Kells has been made Master Mechanic at Cleveland, O.

Ohio River.—The office of President is made vacant by the decease of Col. W. P. Thompson.

Oregon Railway & Navigation Company.—Mr. F. G. Wheeler is Purchasing Agent, with office at Portland, Ore.

Philadelphia, Reading & New England.—Mr. W. J. Martin has been appointed General Manager, vice Mr. C. M. Lawler, resigned.

Pike's Peak.—C. W. Sells has been appointed Manager.

Plant System.—Mr. W. J. McLean has been appointed Master Mechanic of the Third Division, with headquarters at Montgomery, Ala.

San Antonio & Gulf Shore.—Mr. Wm. Davis has resigned the position of President.

Seaboard Air Line.—Mr. John H. Winder has resigned the position of General Manager and the duties of the office will hereafter be performed by the Vice-President.

Southern.—Mr. W. H. Thomas has been appointed Superintendent of Motive Power, vice Mr. R. D. Wade, resigned. Mr. C. H. Hudson, Chief Engineer, has been made Mechanical Engineer also, with advisory duties in connection with the mechanical department. Mr. W. H. Young has been made Master Mechanic of the Charlotte Harbor division, with headquarters at Sanford, Fla.

South Haven & Eastern Railway.—Mr. M. V. Meridith was appointed General Manager, Feb. 1.

Wheeling & Lake Erie.—General Manager Albert G. Blair has also been chosen President. Mr. W. R. Setchell has been appointed Master Mechanic at Norwalk, O., vice Mr. O. P. Dunbar.

Employment.

A young progressive Master Car Builder with large experience in designing and building cars is open for an engagement as Master Car Builder or assistant to same, either in railroad shops or private car line. Address "NEW CARS," care of AMERICAN ENGINEER, CAR BUILDER AND RAILROAD JOURNAL.

AMERICAN ENGINEER CAR BUILDER AND RAILROAD JOURNAL

APRIL, 1896.

CONTENTS.

ILLUSTRATED ARTICLES:	Page.	ILLUSTRATED ARTICLES:	Page.
Ten-Wheeled Compound Freight Locomotive.....	50	Q & C Perfection Oil Paraffin.....	67
Drop-Testing Machine with Spring-Supported Anvil.....	51	Riehle Abrasion Testing Machine.....	67
Wear of Tires on Passenger Engines on the New York Central for the Past 20 Years.....	51	Dickerman Tool Grinder.....	67
Lake Shore & Michigan Southern Passenger Coach with Wide Vestibule.....	52	EDITORIALS:	
Construction and Maintenance of Railway Car Equipment.....	53	Drop-Testing Machine with Spring-Supported Anvil.....	58
Double Eccentric for Class R Engines on Pennsylvania Railroad.....	54	Extended Piston Rods.....	58
An Effective Truss for Coal Car Sides.....	55	Boiler Steel Specifications.....	58
Locomotive Tank with Sloping Coal Space.....	56	Economical Trestle Design.....	58
Protection of Water Glasses.....	56	Starting Gear for Compound Locomotives.....	58
A Comparison of Mechanical Drafts.....	56	The Master Mechanics' Convention for 1896.....	58
Economical Design of Timber Trestles.....	62	The Metric System.....	59
Advantages of Raising the Center of Gravity of Engines.....	63	MISCELLANEOUS:	
A New Brake Beam.....	64	Paragraphs.....	49
Convenient Method of Jacketing Cylinder Heads and Steam Chests of Locomotives.....	61	Communications.....	50
Gibbs' Portable Electric Motor for Shop Use.....	65	Piece Work in Car Shops.....	51
Becker Vertical-Spindle Milling Machine.....	65	Chinese Railway Projects.....	51
Schoen Pressed Steel Car Truck.....	66	Station Name Boards.....	54
Pneumatic Riveter for Ship Yards.....	66	Contributions to Practical Railroad Information.....	54
		Convenience and Efficiency of Locomotive Design.....	65
		The Tobacco Nuisance.....	60
		Personals.....	60
		William G. Watison.....	61
		Nathaniel W. Pratt.....	61
		Notes.....	61
		Trade Catalogues.....	64
		Use of Electricity at Brooks Locomotive Works.....	66
		Use of Compressed Air.....	66
		Lidgerwood Cableways.....	67
		Manufacturing Notes.....	68
		Our Directory.....	68

The Detroit & Mackinaw road will soon order freight cars.

The Lima Northern road in Ohio will soon contract for 12 engines.

The Toledo & Ohio Central Railroad is in the market for freight cars.

The Southern Railway will locate repair shops at Salisbury, North Carolina.

The Lehigh Valley Railroad has issued specifications for and invited bids on 2,000 coal cars.

The Delaware, Lackawanna & Western has ordered ten standard coaches from the Pullman Company.

The Ohio River road of West Virginia will shortly give out contracts for building four new passenger coaches.

The Chattanooga Southern road will immediately order 50 cars to be ready for delivery during April.

The Canadian Pacific is said to have issued specifications recently for building a number of new engines.

The Seattle, Lake Shore & Eastern road will have 120 cars built at the shops of the Oregon Improvement Co.

The Baldwin Locomotive Works has recently received orders for locomotives for two South American railways.

The Mexican National Railway has placed an order for 10 locomotives with the Rhode Island Locomotive Works.

The Wabash Railroad has placed an order for 500 box cars with the Madison Car Company. The order may be increased to 1,000.

The Choctaw, Oklahoma & Gulf Railroad will build shops at Shawnee, O. T., the citizens of that place having contributed \$30,000.

The Chicago Great Western has placed orders for six coaches and two combination cars, each 55 ft. long, with the Pullman Company.

According to the *Locomotive* the number of boiler explosions in the United States during 1895 was 355, in which 374 persons were killed and 519 injured.

The Pennsylvania Railroad has placed an order for 300 coal cars with the Ohio Falls Car Manufacturing Company and 100 with the Mount Vernon Car Company.

The Wheeling and Lake Erie has placed an order for 500 cars with the United States Car Co., and 300 with the Madison Car Co. The order was erroneously reported last month as going to another concern.

The bridge across the Missouri River at Jefferson City, Mo., is practically complete, and it is said the Chicago & Alton and the Missouri, Kansas & Texas will both build short connections that will enable them to use it.

The barbet armor plates recently finished by the Carnegie Steel Co., for the U. S. battleship *Iowa* are so heavy as to require a separate car for the transportation of each plate. The weight of each piece of armor is about 48 tons.

The receivers of the Baltimore & Ohio Railroad have issued an order placing all of the shops on 10 instead of 8 hours time. This order affects about 4,500 men. It will enable the company to improve the condition of its rolling stock.

The Calumet & Blue Island Railway has given an order for 300 cars to the Haskell & Barker Car Company. The cars will have Fox trucks, Westinghouse brakes, Tower couplers, Griffin wheels, Damascus bronze bearings and Chicago roofs.

The Philadelphia & Reading Railroad contracted last month for 1,000 King hopper gondola cars, the order being equally divided between the Union Car Works and the Lebanon Manufacturing Company. The road contemplates ordering 1,500 more cars.

The Buffalo & St. Mary's River Railroad has ordered 20 by 26-inch consolidation engines from the Brooks Locomotive Works. The same company has received an order for two 10-wheeled passenger engines and one mastodon freight engine, with 21 by 26-inch cylinders, for the Adirondack & St. Lawrence.

The East & West Railway of Alabama, has placed an order for 50 box and coal cars with the United States Car Company. The cars will be built at the Aniston shops. The same car company has contracted to rebuild 250 stock cars for the American Live Stock Transportation Company at its Hegewisch shops.

On March 11 the boiler of engine No. 4 on the Delaware, Susquehanna & Schuylkill Railroad blew up near Gum Run, killing four men and badly injuring a fifth. The engine was hauling a train of empties and was in motion at the time of the explosion. The boiler was nearly new and was supposed to be perfectly sound. The exact cause of the accident is not known.

The Seaboard Air Line has ordered several engines from the Richmond Locomotive Works. It is now in the market for 15 heavy freight engines. It will build 300 box cars immediately. Half of these cars to be built at the company's shops at Portsmouth, Va., and the remaining 150 to be contracted for. Later on in the year a further order for 1,000 cars may be given out by the company.

The Northwestern Elevated Railroad, the fourth elevated line in Chicago, has one mile of four track superstructure completed and the steel for a large part of the remainder of the road is on the ground. It is expected that the work of erecting it will proceed at the rate of a block per day, and that the line will be completed by January, 1897. The construction company has thus far spent \$3,591,528.

The citizens of Tyler, Texas, have subscribed \$10,000 toward a fund of \$12,000, which, if raised, will be applied to the purchase of 40 acres of land on which the St. Louis, Southwestern and Tyler Southwestern Railways will extend their yard and shop facilities, they agreeing, in consideration of the contribution of \$12,000 by the city of Tyler, to spend \$40,000 in the extension and enlargement of their shops.

The Baldwin Locomotive Works and the Westinghouse Electric and Manufacturing Company have completed a 200 horse power electric mine locomotive for the Crozer Coal & Coke Company, to be used in the mines at Elkhorn, W. Va. This locomotive is from entirely new designs, and has features that it is expected will make it attractive to mine owners. All of the parts are carefully fitted together and are made of the best material. The weight of the locomotive is about 42,000 pounds.

It is stated, on apparently good authority, that upon the completion of the coast line to Los Angeles, the Southern Pacific will make it a portion of the main line between San Francisco and New Orleans, and will then build large shops just outside of the city and on the same side of the bay. The Oakland shops will then be moved to the new site. The new shops will be very large, perhaps rivaling those of Sacramento. It is not the purpose however, to lessen the importance of the latter plant, but rather to put all of the increased shop capacity required into the new and modern plant.

The largest vessel ever built on the great lakes was launched last month, at the shipyards of the Globe Iron Works, Cleveland. The new steamer is being constructed for the Mutual Transportation Company of that city. Its measurements are: Length over all, 432 feet, 48-foot beam and 28-foot depth. Its net tonnage on an 18-foot draught is 6,700 tons of ore or 200,000 bushels of wheat. With a 14-foot draught it will carry 4,500 tons of ore. It was built in anticipation of a 20-foot channel. The engines are of the inverted cylinder triple expansion type, with cylinders 23, 39 and 63 by 42 inches. She will have four Scotch boilers 11½ feet in diameter by 10 ft. in length.

The Concord & Montreal Railroad will build new shops at Concord, N. H., at a cost of \$300,000. The ground occupied will consist of 28 acres. Five acres will be covered with buildings, which will extend along the main track for about 4,000 feet. The plans include boiler and erecting shops, 410 by 70 feet; two machine shops, 305 by 305 feet; blacksmith shop, 60 by 150 feet; storehouse and office building, 150 by 40 feet; lumber shed, 300 by 400 feet; dry kiln, 75 by 25 feet; wood-working shop, 300 by 60 feet; boiler

and engine house, 85 by 60 feet; pattern, cabinet and tin shop, 200 by 40 feet; passenger repair shop, 163 by 170 feet; freight repair shop, 162 by 170 feet, and a paint shop, 238 by 50 feet.

The annual report of the Illinois Steel Company for the year 1895 illustrates the improved condition of the iron and steel business, particularly when compared with the reports of the same company in 1893 and 1894. For the year 1893 there was a deficit of \$349,472, in 1894 the earnings were only \$30,607, but in 1895 the profits were sufficient to warrant the announcement of a quarterly dividend of 1½ per cent. payable April 1, of this year. The following comparative statement for the three years is striking:

	1893.	1894	1895.
Tons raw material received.....	1,225,428	2,339,370	4,355,243
Tons finished product shipped.....	422,784	503,446	875,098
Wages and salaries paid.....	\$3,230,835.63	\$3,071,391.95	\$6,333,795.81
Average number of men employed daily.....	4,261	5,069	10,382

The gratifying increase in men employed and materials handled is still increasing and with about 12,000 men now on the rolls the prospects are that the company can keep them all employed on full time throughout the present year.

The government of Peru has granted a concession to an American citizen, Cuthbert B. Jones, and his associates, for the construction of a railway from the coast to the district of Hualgayoc, where coal mines of great value are reported to exist. Exclusive privileges are granted for 20 years after the completion of the line, which is to be constructed in five years. A grant is made of one kilometer of public land on each side, and contiguous to the track, for every kilometer of railway, and where there is no public land so situated 200 hectares per kilometer will be located elsewhere. Mr. Jones says that some 40 coal mines in the Hualgayoc district are owned by himself and associates, which it is their chief purpose to reach with their railroads, with the view of supplying the vast demand for coal on the Pacific coast, which is now met with coals transported from remote countries. The main trunk line from the coast to Hualgayoc will have a length of about 130 miles, to which it is designed to add a branch to Chota, 18 miles, another to Cajamarca of 35 miles. It is stated that the route presents no engineering difficulties. English bituminous coal was recently sold at Callao at \$15.50 (gold) per ton.

A bridge on the line of the Union Pacific at Snake River, 14 miles west of Omaha, was recently erected in a remarkably short time. According to the *Engineering Record* the bridge gang, under the superintendence of Mr. E. F. Terry, now of the Terry & Trench Construction Company, of New York, arrived at the bridge site on the evening of Jan. 24. Work was immediately begun on the traveler and falsework for the three west spans, each of 217 feet center to center of end piers. The three spans were erected, floor system in, and ties and guard rails finished on Feb. 8, making a total of 12 working days in which the entire work was done of putting in falsework, removing the old Howe truss spans, and erecting 660 feet of new bridge. The spans are of the design known as the Pegram truss, which is patented by Mr. Geo. H. Pegram, Chief Engineer of the Union Pacific system. The last span was erected in five hours and 20 minutes. The work comprised in the erection means taking the iron from the yard, raising the trusses, and driving all pins, but does not include putting in the floor system. The floor system was changed in this span in four hours. On this work there were directly employed 70 men, and on the traveler there were 28 men and one six-spool hoisting engine. Mr. J. C. O'Melvey is division engineer.

On March 9 President Roberts, of the Pennsylvania Railroad, and a large number of officials and several invited guests, inspected the company's new bridge over the Delaware, which crosses the river at a point about five and one-half miles above the Market street ferry in Philadelphia. This bridge has been constructed to avoid the ferry over the river at Philadelphia, heretofore used for the transportation of both passengers and freight arriving at that city and destined for New Jersey points. The bridge comprises three Pratt truss spans each 540 feet long, and one draw span 390 feet long, making the total length of the bridge proper 1,950 feet. On the Pennsylvania side there is a steel trestle approach 2,200 feet long, and on the New Jersey side one 320 feet long, so that the total length of the metallic structure is 4,470 feet. There is also some wooden trestle work which is to be filled in as soon as possible. The bridge is 50 feet above high water. Besides the great length of the individual spans and the whole structure the work is remarkable for the dispatch with which it was executed. Ground was broken March 13, 1895, and the bridge was inspected March 9, 1896. At that time one track only was laid, and work was progressing on the second one. The great bridge was thus completed in almost exactly one year. It has cost over one million dollars. As soon as traffic arrangements can be completed many of the passenger trains from Atlantic City, Cape May and other New Jersey points will enter Broad street station instead of Camden, thus giving travelers from out-of-town points and the West a direct route to the seashore, besides being a convenience to many people in New Jersey doing business in Philadelphia.

Communications.

Large versus Small Grates.

Editor American Engineer, Car Builder and Railroad Journal:

Referring to your discussion of the relative merits of large and small locomotive grate surfaces, the most usual type of passenger engine, I believe, has a firebox limited to about 2 feet 10 inches wide by the frame, and is, say, 8 feet long, giving 17 feet of grate. If it were possible to widen the firebox without interfering with its other dimensions a great economy in fuel ought to be effected. However, to get more width it is necessary to place the firebox on top of the frames. Outside of mechanical considerations, the effect of this is to put the grate near the level of the door; cold air can rush straight for the tubes, the distances the gases have to pass through in reaching the tubes is lessened, and in addition no brick arch is admissible. In spite of these facts, there is probably a substantial saving to be had by increasing the grate surface in this manner when consumption is over 150 pounds of coal per foot per hour. This refers to a first-class coal, consisting almost entirely of lumps.

The following figures are instructive. Test No. 1 is the evaporation of a certain coal under a stationary boiler where the consumption per square foot of grate was low. The other figures are taken from tests of the same coal made on a locomotive at different times on the same run, but hauling heavier trains when the last test was made.

	Test No. 1.	No. 2.	No. 3.	No. 4.
Pounds of coal per hour per square foot of grate.....	....	82.00	87.1	140.
Equivalent evaporation from and at 212 degrees Fahr.....	6.9 lbs.	6.32 lbs.	6.41 lbs.	5.50 lbs.

The engine used was an 18 inch by 24 inch and had 16.87 feet of grate surface. The figures show a decided drop in the evaporation when the higher consumption of 140 pounds of coal was reached. This was not a superior quality of coal, as is evident by the figures, and it had a large proportion of slack or fine coal.

To take a more striking case. Referring to comparative tests of two compound and one simple engine. One compound and the simple engine had about 30 feet of grate, the other compound engine had a deep firebox between the frames of only about 16½ feet of surface. The two engines with large fireboxes give evaporations ranging from 7.87 to 8.05, with consumption of about 60 pounds of coal per square foot of grate. With 114 pounds consumption the small firebox engine gave an evaporation of 6.59 pounds of water. With 130 pounds consumption it gave only an evaporation of 6.1.

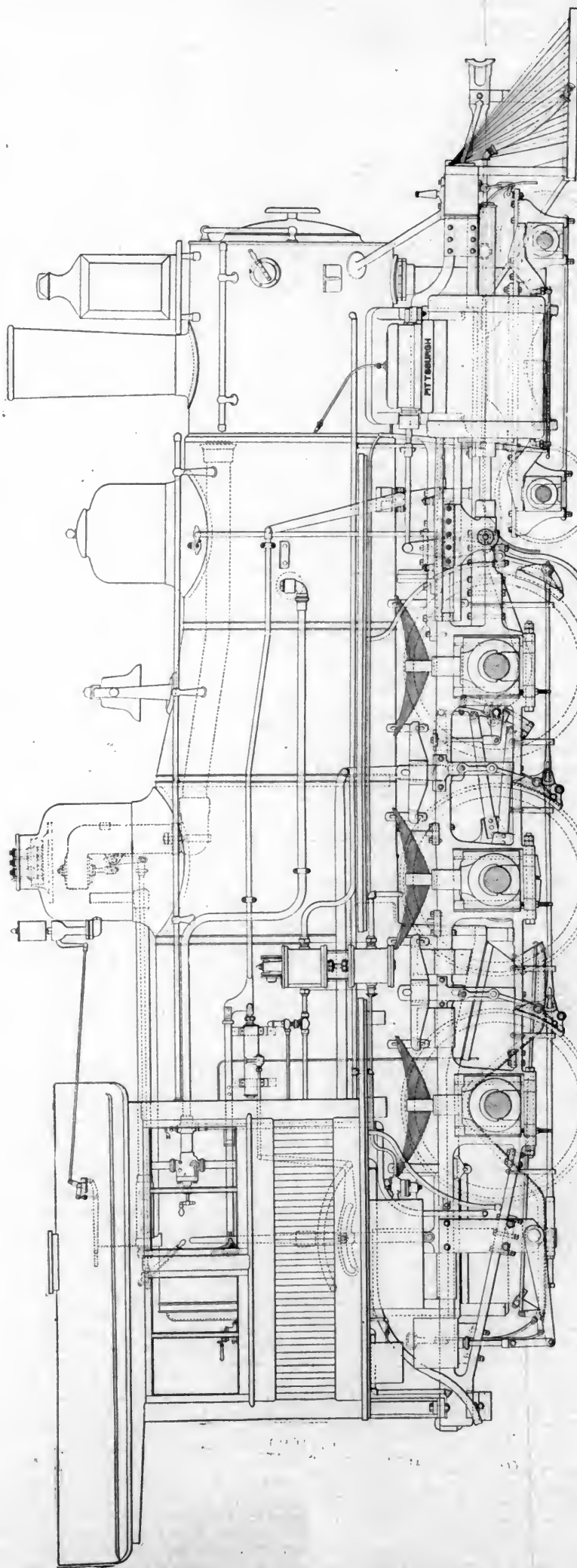
All of the tests referred to were averages of from four to six round trips over the same route and were made with care.

I. H. SCOTT.

[Our correspondent's data and deductions, it seems to us, are hardly conclusive with reference to the relative merits of large and small fire grates. He does not give the amount of heating surface in the different boilers tested. Probably the difference in the results which he reports is due more to the difference in the ratio of heating surface to the rate of combustion per square foot of grate per hour than to the difference in the size of the grates. A locomotive with 18 by 24 inch cylinders would or should have about 1,600 square feet of heating surface. When it is burning coal at the rate of 82 pounds per square foot of grate per hour the ratio of heating surface per pound of coal burned is about 20:1; when burning 140 pounds per hour the ratio is less than 12:1. More than 40 years ago D. K. Clark showed that the greater the amount of heating surface in a locomotive boiler in proportion to the work done the greater the economy, and he also indicated that the smaller the grate for a given rate of combustion—provided the coal could be burned—the more economical the engine would be. If, instead of experimenting with different rates of combustion our correspondent had taken an engine with a large grate and had made his tests with different rates of combustion with the whole grate open; then if he had covered part of it, say a fifth, with fire-brick and repeated his tests, and thus successfully covered two-fifths, three-fifths and four-fifths, each time repeating the tests with different rates of coal consumption, he would then have had the same heating surface all the time and he would have been able to compare the economy of different rates of combustion with varying proportions of grate. Such an experiment would be well worth trying, and probably the information thus revealed would be worth many times the cost of making the tests.—EDITOR AMERICAN ENGINEER.]

Ten-Wheeled Compound Freight Locomotive for the Vandalia Line.—Built by the Pittsburg Locomotive Works.

The accompanying engraving is a side elevation of one of the ten-wheeled compound freight engines which the Pittsburg Locomotive Works recently built for the Vandalia Line for use on its Terre Haute and Peoria Division. The engine has the usual features of the Pittsburg system of compounding, which have already been described in these columns. One feature of this system is the independent exhaust from the high-pressure cylinder and the consequent ability to work the engine simple at slow speeds with greatly increased tractive power. This is an advantage that is being appreciated, particularly on divisions of roads having heavy grades, as it permits the engine to take a heavier load over the limiting grade of the



TEN-WHEELED COMPOUND FREIGHT LOCOMOTIVE FOR THE VANDALIA LINE—BUILT BY PITTSBURGH LOCOMOTIVE WORKS.

division, a load which usually can be easily handled on the remainder of the division.

The engine has an extended wagon-top boiler, with a firebox between the frames, and the crown sheet supported by radial stays. The following are the leading particulars of the engine :

Fuel.....	Bituminous coal.
Gage of track	4 ft. 9 in.
Total weight of engine in working order.....	7,600 lbs.
Total weight on driving wheels.....	101,000 lbs.
Driving wheels base of engine.....	11 ft. 6 in.
Total " " " " and tender.....	21 ft. 8 in.
Height from rail to top of stack.....	49 ft. 9 $\frac{1}{2}$ in.
Cylinders, high pressure, diameter and stroke.....	14 ft. 7 $\frac{1}{2}$ in.
" Low " " " " " " " " " " " " " " " "	29 in. x 26 in.
Slide valves.....	Balanced.
Piston rods.....	Steel, 3 $\frac{1}{2}$ in. diam.
Type of boiler.....	Extended wagon top.
Diameter of boiler at small ring.....	19 in.
" back head.....	60 in.
Crown sheet supported by radial stays.	
Stay bolts, 1 in., hollow stay bolts, spaced 4 in. from center to center	
Number of tubes.....	26
Diameter of tubes.....	12 $\frac{1}{2}$ in.
Length of tubes over tube sheets.....	2 in.
" firebox end de.....	108 ft.
Width.....	32 $\frac{1}{2}$ in.
Working pressure.....	180 lbs.
Kind of grates.....	Cast iron, rocking
Heating surface.....	1,652.0 sq. ft.
" firebox.....	152.0 sq. ft.
Total heating surface.....	1,405.0 sq. ft.
Grate area.....	24.0 sq. ft.
Diameter of truck wheels outside of tire.....	66 in.
" and length of journals.....	8 in. x 9 in.
" of driving wheels.....	28 in.
" and length of journals.....	6 in. x 10 in.
" of tender wheels.....	33 in.
Water tank.....	Level top.
Water capacity.....	4,000 U. S. gallons.
Fuel capacity.....	\$3,700 fuel.
Weight of tender with fuel and water.....	87,700 tons.
Type of brake.....	Weastinghouse American Automatic

Piece Work in Car Shops.*

G. L. POTTER.

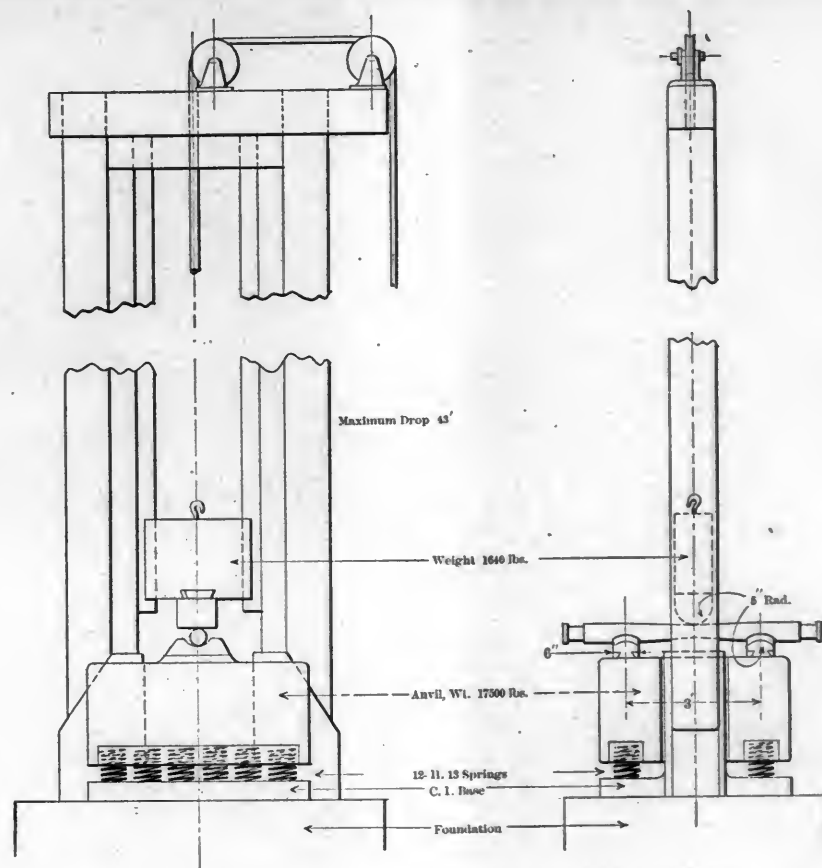
The manufacturing and repairing of the parts of locomotives under the piece-work system had been practiced a number of years before the system was applied to car work, especially to the repairing of cars. This was due probably to the fact that the amount of money expended on locomotive work is so great per unit; that is, per engine built or repaired, and the labor such a large percentage of the total cost; in new work being about 45 per cent. and in repair work from 65 to 70 per cent., while the cost of labor in building new cars is only from 12 to 15 per cent. of the total cost, and in repairs from 45 to 50 per cent. It is also due to the fact that, on account of the much longer time required to perform the different operations on locomotive than on car work, it is much easier to determine the prices that should be paid, and with much less danger of error.

This trouble in determining the prices to be paid is not so great in building new as in repairing old cars. In new work it is customary in some cases to place prices on the body complete with all the trimmings; i. e., doors, grain doors, air-brakes, etc., applied; in other cases the work is divided up and given out to different gangs of men, one gang constructing the foundation, another laying the floor, another putting up the upper structure, another putting on the sheathing, another the roof, etc., so that it requires from one half to a day and a half in the first case, and an hour to five hours in the second, to complete the different operations; consequently the amount of time that should be required is comparatively easy to determine. This is also the case in manufacturing the parts for new work. While each piece can be manufactured in a comparatively short time, they are usually gotten out in large quantities, so that the time required to produce each piece is readily determined.

In repair work the conditions are different. Different cars will require different parts to be repaired, so that it is necessary to establish a price for removing and replacing and repairing each part. The difference in time required to remove the corresponding parts on different cars (even though they be of the same design), and the difference in the time required by different men to perform the same work, and the getting out of the parts in small numbers, are the main difficulties encountered in arriving at prices that are fair to both employer and employee. This can be accomplished only by thorough and careful investigation, extending over considerable time and averaging as many performances of the different operations as possible. When the work has been carried through to a successful issue, the results will well repay for the labor expended.

The benefits of the piece work system accrue not only to the employer, but also to the employee; to the former in that he pays for the work performed only what it has been found to be worth, can more easily locate and weed out the incompetent workman, and, with given facilities, will materially increase the output of the plant; to the latter in that he is paid for what he actually does and by increased exertion can increase his earnings, and the more competent workman is enabled to reap the benefits of his greater earning capacity.

There is probably more supervision required under the piece work than under the day work system, in the first place to see that only such parts that actually require it are repaired. There is a great tendency on the part of workmen to renew more parts than are actually necessary, especially if by doing so the earnings can be increased. To provide against this it is customary to have the car thoroughly examined before being taken into the shop, by a competent inspector, who notes on a blank the work to be done, and only such work as is so noted is allowed to be done without permission of the foreman in charge. In the second place the cars should be carefully inspected after completion, to see that all the work called for on the blank has been done and done in a proper manner, the inspector checking the items called for on the blank upon which the parts to be repaired have been entered against the parts repaired on the car. In the third place, there is danger of material being wasted by



Drop Testing Machine with Spring Supported Anvil—Pennsylvania Railroad.

unscrupulous workmen, especially if parts can be removed more quickly and easily by destroying them. This is particularly the case in truck work, where it is easier to break the bolt off than to take off the nuts.

In starting the piece-work system in a railroad shop, the first impression that is usually formed in the minds of the workmen is that it is a scheme to reduce wages. It is necessary, therefore, to successfully establish a system, to disabuse their minds of this idea and to have them feel that the benefits will be mutual. Failures to introduce the system successfully, where it has been undertaken, can, I think, be traced in the majority of cases to unfair dealings on the part of those in charge, by reducing the prices when it was found that by extra or unusual exertions the workmen were enabled to materially increase their earnings, thus discouraging them and causing them to look upon the scheme with suspicion.

When the piece-work system has been established on a fair and equitable basis, it will be found that the cost of the output will be very much reduced, the workmen will be enabled to increase their earnings, and there will be much less dissatisfaction among them, and a great stride in the solution of the labor problem will have been made.

A Spring-Supported Anvil for Drop-Testing Machines.

In drop testing machines the effect of a weight falling from a specified height is considerably modified by the weight of the anvil and the character of the foundations under it. So greatly does this influence the results obtained that couplers and other articles of manufacture which have met all tests satisfactorily under one drop have been known to fail under others having more substantial anvils or foundations. All axle or coupler drop-testing machines have until recently been constructed with anvil blocks which were not heavy enough to resist with their inertia the whole force of the blow, but had to depend more or less upon the foundations under them. The heavier the anvil the less duty the foundations were called upon to perform, but in all cases the latter had to take much of the force of the blow, and they introduced an element of doubt into the results which prevented reliable comparisons between the data obtained on different machines, or upon the same machine at different seasons of the year.

To overcome these difficulties the Pennsylvania Railroad has reconstructed its axle drop at Altoona, putting in an anvil heavy enough to meet the force of all blows with its own inertia, and supporting this anvil on springs. Through the courtesy of Mr. F. D. Casanave we present the accompanying illustration of the drop as it is now arranged. It will be seen that on top of the foundations a cast-iron base is placed that forms a seat for the 12 springs which support the anvil. This anvil is a solid block of cast iron approximately 4 feet by 5 feet by 2 feet, and weighing 17,500 pounds. The axle supports are separate pieces dovetailed into the upper face of the anvil and placed the regulation distance apart of three feet. The springs which support the anvil are each composed of two coils, the outer one being 8 inches in diameter and made from steel $1\frac{3}{8}$ inches in diameter, while the inner one is 54 inches in diameter and

composed of $\frac{1}{4}$ -inch steel. The springs are $9\frac{1}{4}$ inches high when light and $5\frac{1}{2}$ inches when solid. Compressed to a height of 7 inches the total supporting power of the 12 springs is 80,000 pounds.

It will be evident that in practice this anvil always presents the same resistance to the action of the drop falling from a given height. This resistance is chiefly made up of the inertia of the mass of iron, weighing 17,500 pounds, and any movement of the anvil that may take place is against the force of the springs which support it. Constant conditions are thus obtained and the rigidity of the anvil is not altered by the freezing of the ground or other changes that are unavoidable. This is an excellent improvement and if others using the drop testing machine to test their outputs or to test materials received would employ the same construction and weight of anvil, the results obtained would always be comparable with the work done on other machines of the same design, something which cannot be said of the drops in use at present.

Wear of Tires on Passenger Engines of the New York Central for the Past Twenty Years.

Comparing the weights upon the drivers a few years ago with those in present use shows an increase in the static or dead load of some 65 per cent., while the increased speed of the trains now produces dynamic effects more than double the static loads, yet by increasing the width of the head of the rails as they were renewed and the higher standard of track maintained, the rate of the wear of tires for the heavier locomotives has not increased, but, on the contrary, decreased. In 1883, on the 65-pound rails, deep and narrow type of heads, drivers carrying 13,360 pounds ran an average of 19,400 miles for a loss of $\frac{1}{16}$ inch in thickness of the tires. This was the second type of 65-pound rails, the first one having been rolled in England and had a wider head.

In 1844 the 3 inch pioneer 80-pound rail was put in service, the head being 2½ inches wide. Its use was yearly extended, and by 1880 locomotives on the Hudson division made nearly one-half their mileage on the 80-pound rails. Engines then carrying 17,600 pounds per driver ran an average of 19,300 miles per ton of 4½ inch in thickness of tire.

In 1981 passenger engines on the Hudson division made their entire mileage on the 80-pound rails, while those on the Mohawk and Western divisions made about three-quarters of theirs on the same class of rails; drivers carrying 20,000 pounds ran an average of 19,400 miles per loss of one-sixteenth inch in thickness of the tire. This refers to the loss by wear and returning for future service.

In 1892 the 100-pound rail, head 8 inches wide, was laid on the Harlem line, which carries the combined passenger traffic of the three railroads entering and leaving Grand Central Station, New York City. The renewing of the entire line of the New York Central & Hudson River Railroad from Mott Haven Junction to Buffalo and return with 80-pound rail was completed in 1892. In 1894 the 100-pound rail was laid from Spuyten Duyvil to Peekskill, making about one-quarter of the Hudson Division laid with 100-pound rails.

In June, 1895, I asked Mr. William Buchanan, General Superintendent of Motive Power and Rolling Stock, for the mileage of some of the class "I" engines running over the 80 and 100-pound rails. When the class "I" engine was de-

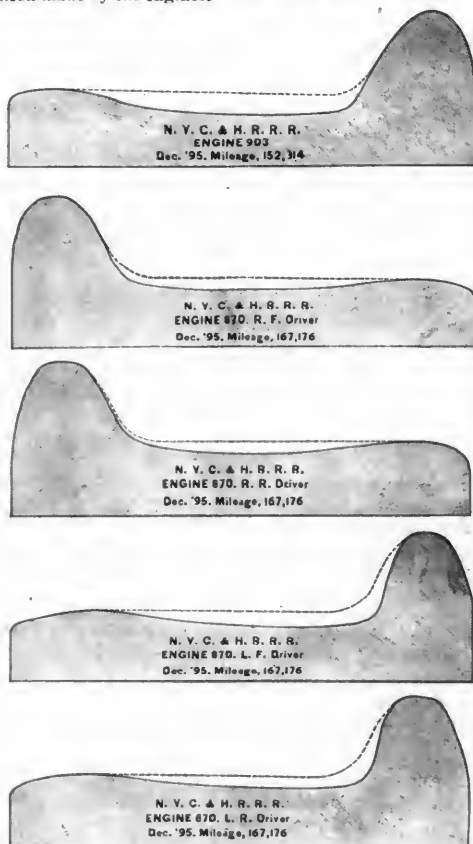
* Read before the Western Railway Club in February, 1896.*

signed in 1889, the weight on each driver was 20,000 pounds, but as the 80-pound rails were put into the track the weights have been increased to 22,000 pounds. The total weight of the locomotives in running service is 200,000 pounds or over 40,000 pounds being upon the truck. The mileage of the tires only includes one turning since October, 1892, and ends March, 1895. Some of the engines, of which there were 43 in all, did not enter service until 1893, and others in 1894.

The list is so large, covering such a wide range of service, that it must show conclusively whether or not a broad flat topped rail increases or decreases the rate of wear of tires running over them. The 43 engines ran 3,706,567 miles and the total loss in thickness of tires in sixteenths of an inch was 180, or an average of 23,166 miles for a loss of each $\frac{1}{16}$ inch of tire. Twenty-three of the engines which ran in part over the 100-pound rails show an average mileage of 29,046 miles for each $\frac{1}{16}$ inch loss in thickness of the tire. The mileage of 19,400 miles per loss of $\frac{1}{16}$ inch in thickness shown by the light engines on the 65-pound rails is now much exceeded by the heavier engines on the 80-pound rails, the average mileage being 23,166 miles, and on the 100-pound rails it will exceed the 29,046 miles, which over one-half the present engines now show by only making a part of their mileage on the wide rails.

The comparison between the wear of tires on the engines running the "Empire State Express," over the Hudson division, making one fourth of the mileage on the 100-pound rails, and the one running over the Western division exclusively on 80-pound rails is very interesting.

The engravings show the approximate wear as obtained by plaster casts after the mileage indicated; on them had been made by the engines.



Diagrams Showing Wear of Tires on Engines No. 903 and No. 870.

Engine 870 commenced the service for which the wear of the tires is shown May 25, 1894, and completed it Dec. 21, 1895. The engines are double crewed, as is customary with all, and the mileage made per month fluctuated between 8,571 and 9,200. Out of the 575 days the engine was worked 571 days, the 4 idle days being occupied in boiler washing. The total mileage in that period was 167,176 miles. During all this time the tires were not drawn except on the four idle days.

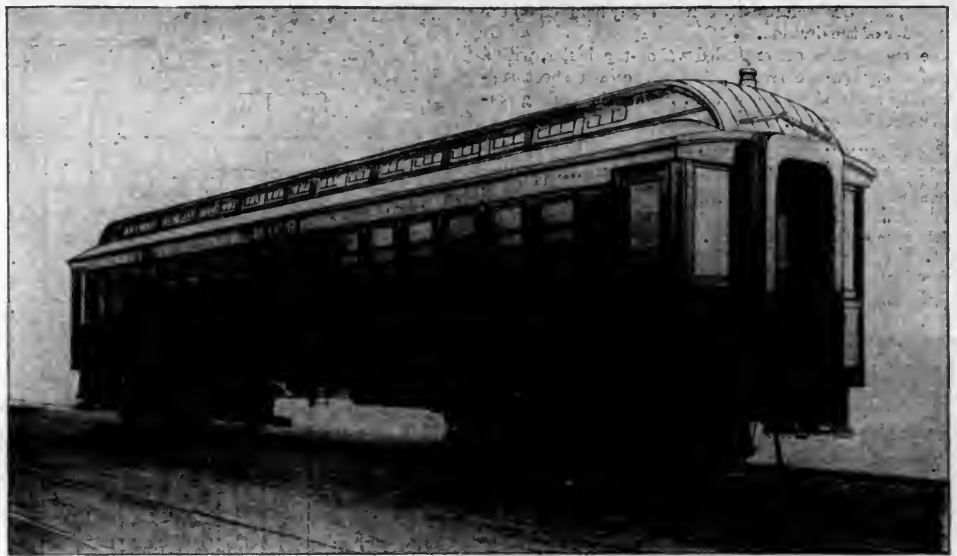
The following table shows the wear of tires with different weights on them and running on various rail sections:

No. of engine.	No. of miles run.	Circumference of tire in feet.	Pounds of metal lost per 1,000 m. run, 4 drivers.	Rail section on which engines ran.	Weight on each driver.
870	167,176	20.41	0.801	80 and 100-lb.	20,000 lbs.
903	152,314	22.00	1.332	80-lb. rails.	22,000 lbs.
84	56,219	18.06	1.234	English 65-lb. rail	15,000 lbs.
86	73,617	18.06	1.387	" " "	15,000 lbs.
4	78,364	17.28	1.379	" " "	15,000 lbs.

Note.—The 100-pound rail has a head 3 inches wide, the 80-pound rail a head 2½ inches wide, and the English 65-pound rail had a head 2½ inches wide.

The loss per yard in circumference of tire, per 1,000,000 tons rolling contact on the rails was as follows:

No. 870.....	0.012 lbs.
No. 903.....	0.070 lbs.
No. 84.....	0.121 lbs.
No. 86.....	0.136 lbs.
No. 4.....	0.132 lbs.



Passenger Coach With Wide Vestibules.—Lake Shore & Michigan Southern Railway.

The general dimensions of the class "I" engines are given in the following table:

Cylinder, diameter and stroke.....	19 × 24 in.
Steam port.....	18 × 1½ in.
Exhaust port.....	18 × 3¼ in.
Valves.....	1½ in. wide.
Travel.....	3½ in.
Outside lap.....	1 in.
Inside lap.....	None.
Boiler—	
Diameter, smallest ring.....	38 in.
Pressure per square inch.....	170 lbs.
Firebox—	
Length, outside.....	105½ in.
Width.....	40¼ in.
Area.....	27.3 sq. ft.
Heating surface.....	150.8 sq. ft.
Flues—	
Number.....	208
Outside diameter.....	5 in.
Length between sheets.....	11 ft. 11 in.
Heating surface.....	1670.7 sq. ft.
Total heating surface.....	1821.5 sq. ft.
Weight of engine in working order.....	120,000 lbs.
Weight on drivers.....	80,000 lbs.
Weight, maximum tender load.....	40,000 lbs.
Tractive force per pound M. E. P.....	111.07
Adhesion to tractive force.....	0.20
Diameter of drivers.....	78 in.
Driving wheel base.....	8 ft. 6 in.
Total wheel base of engine.....	22 ft. 9 in.

Engine No. 903 hauled the "Empire State Express" on the western division from April 3, 1894, to Dec. 3, 1895, total mileage 152,314. Of the four tires of engine No. 870, the left front one, was physically the softest and shows the most wear as seen in the accompanying illustrations. Both front drivers show increased wear over the rear ones from crushing the sand when first applied to the rails, and is more noticeable than on the crucible steel tires of the lighter engines of which I took plaster casts many years since. Ross Mechan which were applied to the drivers covering the full tread and flange of all drivers for both engines. On No. 870 considerable wear was produced on the outside of the flanges of the left side drivers, which is not included as it was not produced by the rails.

The wear of tires per 1,000,000 tons rolling contact on the rails for the amount of metal lost, as shown by plaster casts, would be influenced by many conditions which need not be considered here, yet the results point to the same general fact that by widening the top of the rail, and giving it a larger top radius, the rate is decreased, notwithstanding an increased weight is carried upon the drivers. The top radius of the pioneer 80-pound rail is 12 inches, with $\frac{1}{8}$ inch corner radii, and for the 80-pound and 100-pound rails, laid in 1892 and since, it is 14 inches, and corner radii of $\frac{3}{8}$ inch. The important point is to secure as large an area of contact between the drivers and the rails as practicable, for the larger the area is the less are the wheel pressures per square inch of contact, and the greater width of metal of both rails and wheels to resist and distribute the tractive force exerted. The tractive force of both 870 and 903 on the rails drawing the same train would be practically alike, and the difference in wear of tires mainly due to the greater average area of contact of 870, running part of its distance on the 100-pound rails, while 903 ran entirely on 80-pound rails. The mileage of either engine is very large, nearly double what is obtained on the narrow-headed rails, as will be seen by a comparison with engines Nos. 84, 86 and 4, which ran on the 65-pound rails. The practical results of introducing the broad-topped stiff rails show a decreased wear of tires, frogs, rails, ties, and expense of minimum maintenance while the speed and train loads have been largely increased. The standard freight train load of the New York Central & Hudson River Railroad, on the 80-pound rails, is 50 loaded 80,000-pound capacity cars, making a gross load of 2,250 tons, forming a train 2,000 feet long, which runs 150 miles in six to eight hours. The train load has more than doubled from the old 65-pound rails.

The broad thin type of head is making rapid progress abroad. Dr. Haarman at his Osnabruck works, Germany, has introduced several sections, while many are being rolled in England for India and Australia. My 80-pound section has recently been rolled in England for two Canadian lines.

While the thin wide head and stiff type of rails is now generally recognized as the most economical form, the pioneer 5-inch 80-pound rail met with decided opposition as being heavier and stiffer than was needed. Its introduction was largely due to the persistent efforts of Mr. J. M. Toucey

then General Superintendent but now General Manager of the New York Central & Hudson River Railroad. The rail once in the track made friends and had strong advocates for the value of stiffness in a section was recognized, the principle being utilized by many railroads. It is not weight alone but stiffness as well which gives value to a section. It marked an epoch in railway progress, and while the advantages of a broad head and stiff 5-inch rail have exceeded expectations there are still greater values to be obtained by the use of the broader head and stiffer 103-pound rail.

P. H. DUDLEY,
New York.

Passenger Coach With Wide Vestibules.—Lake Shore and Michigan Southern Railway.

The Lake Shore & Michigan Southern Railway is equipping some of its first-class passenger coaches with wide vestibules, and the first one, which was recently turned out of the Cleveland shops, is illustrated in this issue. As will be noticed, the vestibule extends the full width of the car, and is provided with windows in the ends and doors extending to the bottom of the sheathing on the side. The steps are stationary and are covered with trap doors, which can be opened from the outside as well as the inside of the vestibule. Gates close the opening in the vestibule when this is at the rear end of the train. The vestibule is the Gould pattern with wide buffers.

The car is 52 feet 6 inches long over endsills and 61 feet over couplers, 9 feet wide over side sills and 14 feet 7 inches high over all. End sills and side sills are double and are reinforced by iron plates. The end of the car is strongly built, without windows and the posts are reinforced by iron bars.

The interior finish is mahogany, plainly but neatly carved. The sash is compound, allowing the lower one to be raised high enough so as not to obstruct the view when open. The deck sash is hinged at the end and is glassed with light yellow odyoyant glass.

The car has two saloons, located at diagonally opposite corners and at the ladies end there is a lavatory and water cooler. The car seats 62 people and the seats in the car illustrated are the Hall & Kilburn "walkover," upholstered with seal brown figured plush; the curtains are the Adams & Westlake "Acme."

The car is lighted by Pintsch gas, supplied by one reservoir, the body of the car having five 4-burner lamps and each vestibule one 2-burner lamp. The heating is by direct steam, two rows of 2-inch pipe on each side of the car being sufficient in the coldest weather.

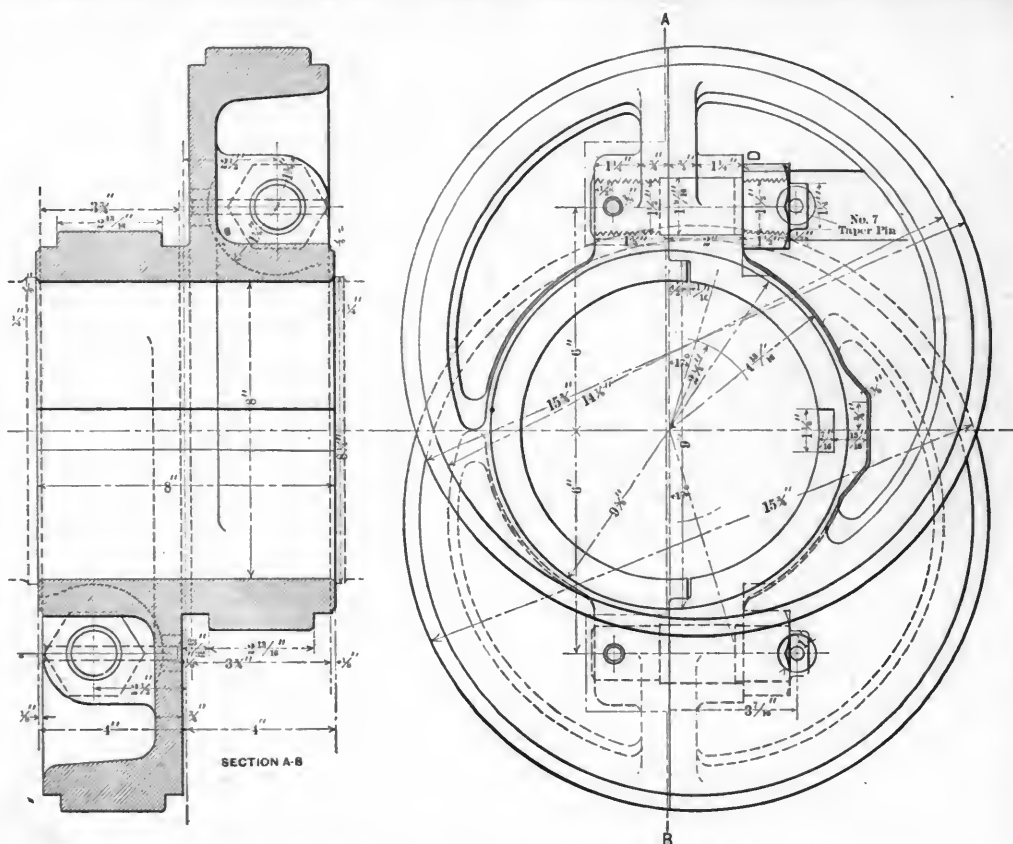
The trucks have a wheel base of 8 feet, have 42-inch Allen paper wheels and National Hollow brake beams.

The car complete weighs about 68,000 pounds. The illustrations show the exterior of the car painted a dark color, which is the standard color of the Wagner Palace cars. The striping is in gold, plain and neat. This car with another one like it, will run on the South Western Limited between Buffalo and St. Louis.

Ten other cars are to be similarly equipped, but will be painted the standard Lake Shore yellow and will be used in through service between Buffalo and Chicago.

At the Great Northern works at Doncaster, England, there is being constructed what is probably the largest sleeping car in Great Britain. It is 66 feet 8 inches in length, 9 feet in width, and 18 feet 2 in. in height, and so fearful were the officials of its adaptability to the physical conditions of the road, that the completed framework was recently run over the line from Edinburgh to Aberdeen, in order to see whether it could successfully take the curves on the road. The trip was entirely successful, and the carriage was taken back to the shops to be completed, when it will be put into service on the east coast route. The carriage will be finished in a very elaborate manner.

The Long coal unloading machine erected on the N. Y. P. & O. coal dock at Cleveland unloaded over 4,000 cars of coal between Sept. 17 and Feb. 1, 1896, notwithstanding the fact that it has stood idle more than one-half of the time waiting for cars and boats. This machine consists of a cylinder which receives the car within it and then rolls it over bodily, dumping its contents into chutes that lead to the hold of the vessel being loaded. Future machines will be so constructed that only two men will be needed to operate them.



Double Eccentric for "Class R" Locomotives—Pennsylvania Railroad.

Double Eccentrics for Class R Locomotives on the Pennsylvania Railroad.

In the accompanying illustration we present the drawing of a "double eccentric" in use on Class "R" locomotives on the Pennsylvania Railroad. This "double eccentric," as it is called on the road, consists of two split eccentrics cast together, two castings only being required in place of the four usually employed, and the object of this method of construction is to obtain greater strength and better fastenings. The eccentrics are split at right angles to the customary line of division, and the two parts are bolted together by two studs $1\frac{1}{4}$ inches in diameter. The hub and rim of each eccentric are united by a plate or web $\frac{1}{2}$ inch thick and at the joint between the castings there is a cross web of the same thickness with a boss on it $1\frac{1}{2}$ inches high for the stud. The studs are screwed into one-half and each held in place by a $\frac{1}{2}$ -inch rivet passing entirely through the stud and boss. At the other end of the stud is one nut secured by a No. 7 taper pin. A 1-inch hole in the web of the eccentric opposite the taper pin makes it accessible from either side.

After planing the joint between the two castings which make up the double eccentric, they are put together with one thickness of heavy manilla paper between them and bored for the axle fit. The paper is then removed and the eccentric clamped onto a mandril for turning. This mandril has in its ends centers correctly located for both the throw and angular advance.

The completed eccentrics are evidently adapted only for one angular advance which cannot be changed in forward gear without distorting the back gear, but on a road having so many locomotives of one class as the Pennsylvania Railroad, this is no objection. Of course it would not pay to make eccentrics in this manner where the locomotives were few in number and their valve gears were not duplicates in every detail, but in the case cited it does pay, and a more substantial piece of work is obtained than is possible with the common construction. They have been used on Class "R" engines for more than a year with excellent results.

Chinese Railway Projects.

Advance sheets of consular reports for March contain a communication from the United States minister at Peking, on railroad enterprises in China, from which it appears that a decree has been issued by the Emperor, placing the construction of the railroad from Tientsin to Lu Kou Bridge, eight miles west of Peking, in the hands of Hu Chufen, a native of Kwangsi province, holding the rank of provincial judge, and a man who has had some experience with the Tientsin railroad. The cost of the line (approximately 70 miles) is stated in the decree to be 2,400,000 taels (about \$2,000,000 United States currency), or more than \$28,000 per mile. An American engineer recently estimated the cost of this line at \$20,000 per mile, with rolling stock and equipment complete. The proposed route presents no difficulties except the necessity of high embankments and numerous drains and culverts in certain localities to cope with annual floods. It is understood that Mr. Hu's instructions are to employ no foreign capital whatever. He is said to have already 4,000,000 taels at his command, and it is said he proposes to finish the line within a year. A part of the decree

ordering merchants to form stock companies for railroad building outlines the present railroad policy of China. There is a strong determination on the part of the Government to exclude foreign capital and foreign control. There is reason to believe, however, that this determination will give way before the magnitude of the undertaking which will bring to light the inexperience of the Chinese managers. There will then be a great field open there to foreign railroad enterprise.

This field has already attracted great attention, and it will doubtless be eagerly disputed by the representatives of the railroad interests of various nationalities. United States Minister Denby has urged on the Chinese authorities the pre-eminence of the Americans in railroad construction, and in the manufacture of all those products which China's railroad system will in time require. It would be much to be regretted should this market be allowed to pass without an effort into the hands of others.

Concerning another enterprise, the *North China Herald* of Jan. 17, 1896, says: It is reported, upon what seems to be good authority, that the Liangkang viceregal government has given the construction of the Shanghai-Soochow Railway to a cosmopolitan syndicate, at the head of which is a Belgian. The Chinese are to borrow the money for construction from the syndicate, the loan to be repaid in installments beginning from the third or fourth year after trains have commenced running between the two cities. The object of this is to make the railroad obstructionists in Peking believe that Chinese capital has been employed in the construction of the road. The terminus of this railway is to be at Sinza (Chinese territory), where also will be the freight and passenger offices of the semi-government steamboat line to run between Shanghai, Soochow and Hangchow.

Station Name Boards.

On account of the many complaints received by the British Board of Trade as to the inconvenience caused to the traveling public by the ineffective manner in which the station names are indicated at railway stations, a circular was sent out to the various railway companies of the United Kingdom asking them to state what steps they proposed to take in order to deal effectively with the subject. The replies to this circular are contained in a blue book just issued. Among the various companies whose answers are given, the Great Northern Railway Company state that they have decided, with a view to keeping the names of the station distinct from advertisements, to show the names on angular boards projecting from the station walls, and also on platform lamps, and, when practicable, waiting-room windows. The Great Western Company report that they have taken steps to provide distinctive name-plates at all new stations, and to rearrange those at existing stations (when these stations are renovated), so as to leave a space of 12 inches between the name-boards and advertisements. A standard pattern of name-board has been adopted, and the boards are fixed in prominent positions. The names are also shown on lamps and seats. The Metropolitan Company report that the names are shown at their stations on boards and platform lamps and seats, and that they have given notice that all advertisements must be removed 18 in. clear of the name-boards. They have also provided additional boards, which, to prevent confusion with advertisements, bear the word "station." The Metropolitan District Railway, after describing the way in which the names are displayed at their stations, add that they have also decided to adopt an apparatus for automatically indicating in each compartment the name of the station the train is approaching. The Cal-

edonian Company propose to make arrangements to prevent advertisements from being placed in close proximity to the name-boards. The majority of the other companies express the opinion that their present arrangements in respect to station names are satisfactory; but a number of them add that they will be glad to consider any recommendation which may be made to them on the subject.

It would be in order if we had a national Board of Trade to make a similar inquiry in this country. The elevated railroad in New York especially should improve its signs for the use of travelers at night. The names of the stations should be inscribed in some way in the glass globes of the gas lights. It is now very difficult for a stranger, or even native New Yorkers, to tell what station "he is at" in the night.

Contributions to Practical Railroad Information.

Chemistry Applied to Railroads.

SECOND SERIES—CHEMICAL METHODS.

XVII.—METHOD OF DETERMINING PROPORTIONS OF OIL, PIGMENT AND MOISTURE, OR DEFICIENCY OF HYDRATION IN FREIGHT CAR COLOR.

By C. B. DUDLEY, CHEMIST, AND F. N. PEASE, ASSISTANT CHEMIST, OF THE PENNSYLVANIA RAILROAD.
(Copyright, 1891, by C. B. Dudley and F. N. Pease.)

EXPLANATORY.

The standard freight car color of the Pennsylvania Railroad Company is bought in paste form, and the paste must contain nothing but oil, pigment and moisture. The moisture and other volatile constituents must not exceed 2 per cent. of the weight of the paste, and the paste must not be a "liver" when received. The oil must be pure raw linseed oil, and must not be less than 23 nor more than 27 per cent. of the weight of the paste. In determining the proportions of oil, pigment and moisture, or other volatile constituents, the oil must be heated before weighing to 250 degrees Fahrenheit, and the pigment must be dried before weighing at from 60 to 90 degrees Fahrenheit in air which has been artificially deprived of moisture. The inert material in the pigment may be sulphate of calcium or gypsum, silica, kaolin, soapstone or asbestos, the two former preferred. Carbonate of calcium must be present to the extent of 2 per cent., but must not exceed 5 per cent. of the weight of the pigment. Ground feldspar is not desired, and barytes or sulphate of barium, organic coloring matters and caustic substances are excluded. The pigment must contain not less than 20 per cent. of sesquioxide of iron, and if sulphate of calcium or gypsum is present, it must be fully hydrated. The paste must conform to standard shade, and must pass test for fine grinding.

OPERATION.

Weigh a six-ounce Erlenmeyer flask and then introduce five grams of the paste to be examined. The manipulation of the paste is not entirely easy. It is best to weigh the material into the flask, using a narrow spatula to transfer it and taking great pains to prevent any of the paste from getting on the outside of the flask, or near the top on the inside. Fill the flask about one-third full with 38 degrees Beaume gravity gasoline, and agitate with a rotary motion in a horizontal plane, until the paste is all decomposed. Now add more gasoline and agitate in the same way to secure mixing, until the flask is about two-thirds full, and finally add gasoline from the jet of a wash bottle, so as to mix as thoroughly as possible, until the flask is nearly full. Cork loosely, without permitting the liquid to touch the cork, and allow to settle, which may require from two hours to two days. When the liquid is clear, carefully remove the cork, and decant the liquid into a tall lipless beaker, holding about nine ounces. By using sufficient care, the liquid may be decanted down so that not over five cubic centimeters are left in the flask. Some skill and a little experience are required to secure this result. Incline the flask and allow perhaps half the liquid to run out. Then if the pigment has not already collected at the lowermost point of the flask, keep the flask inclined just so the liquid will not run out, and assist the collection of the pigment at the lowermost point, by striking the flask gently against the desk. If this operation roils the liquid near the bottom of the flask, place it still inclined in the top of a beaker or other support and allow to settle again, which usually takes only a short time. Then continue the decantation until the limit is reached. Place the beaker where the temperature is a little above the boiling point of the liquid, and where there are no naked lights and then fill the flask with gasoline again in the manner before described. Allow to settle a second time, and repeat the decantation in the same manner. Enough of the liquid in the beaker will, if the evaporation is properly managed, go off while the pigment is settling the second time to furnish room for the liquid for the second decantation. Evaporate the liquid in the beaker as before, gradually raising the temperature as the liquid will bear it, until a temperature of 250 degrees Fahrenheit is reached. Cool and weigh from time to time, and continue the heating at the same temperature until constant weight is obtained. This weight, minus the weight of the beaker, is the weight of the oil. After the second decantation add to the flask containing the pigment three or four cubic centimeters of a mixture of equal parts of ethyl alcohol and distilled water, agitate, to secure

thorough mixing, cork with a double perforated rubber cork carrying two tubes, one of which reaches to within an inch of the bottom, and attach the other to a steam or water aspirator, or other means of drawing air through the flask. The air drawn into the flask should not carry dirt, or injurious gases along with it. The gasoline, the alcohol and the principal portion of the added water are removed in the course of a few hours. As soon as the visible liquid has disappeared, attach to the air inlet tube an arrangement for passing the air through concentrated oil of vitriol, and continue the drying until the flask containing the pigment shows constant weight. Deduct the weight of the flask from this weight, and proceed as explained under calculations.

APPARATUS AND REAGENTS.

The flasks and beakers required are perhaps sufficiently designated above.

The arrangement for taking moisture out of the air used in drying the pigment by causing it to bubble through concentrated oil of vitriol may, perhaps, be readily improvised in every laboratory. Drechsel's wash bottles for washing gas, with ground glass joint, are very convenient for this purpose.

The gasoline specified is readily obtained in the market. It is best to obtain it in tin cans and every new shipment should be tested. If the same amount used in an analysis leaves a weighable residue, when a blank oil determination is made, a correction corresponding to this should of course be made. It is better, however, to secure such a grade of gasoline, that no residue will be left. If the gasoline is not shipped or stored in wood or dirty cans, very little difficulty will occur.

The ethyl alcohol is the ordinary 95 per cent. alcohol of the market, and the ether mentioned later is the ordinary commercial sulphuric ether of the United States Pharmacopoeia.

CALCULATIONS.

The weight obtained by deducting the weight of the beaker from the constant weight of the beaker and oil as above described, gives the weight of oil in 5 grammes of the paste. Let us suppose this to be 1.1865 grammes. Then the percentage of oil would be $(1.1865 \times 100 \div 5) = 23.73$. Also if the pigment in the paste were fully hydrated, the weight of the flask and pigment, minus the weight of the flask, gives the weight of the pigment in five grammes of the paste. Suppose this to be 3.7240 grammes. Then the percentage of pigment would be $(3.7240 \times 100 \div 5) = 74.48$. In this case, if no volatile constituent but moisture is present, the moisture would be $100 - (23.73 + 74.48) = 1.79$ per cent., the moisture being determined, as is seen, by difference. In case the pigment in the paste was not fully hydrated, the water added with the alcohol accomplishes this result, and the sum of the oil and pigment, provided no other volatile constituent was present, always exceeds 100 per cent., the excess representing the deficiency of hydration of the pigment, as is readily seen.

M. S. C. NOTES AND PRECAUTIONS.

It is quite apparent that this method involves as its principal features the insolubility of the pigment in gasoline, the solubility of the oil in the same menstruum, and the volatility of the gasoline without vaporizing either the oil or the pigment.

It frequently happens that samples of paste are found, the pigment of which settles very slowly. With many of these samples, the addition of 3 to 5 cubic centimeters of a mixture of equal parts of ethyl alcohol and distilled water, while decomposing the paste, facilitates the settling.

It is best to add this alcohol and water before the second addition of gasoline in order to secure thorough mixing. After a little experience is gained, the behavior of the pigment when the paste is decomposed and before the second addition of gasoline, is something of a guide as to whether the alcohol and water are needed. If the pigment shows a disposition to settle off readily on allowing the flask to stand a few minutes, the alcohol and water will probably not be needed. If there is no such disposition, it is better to add them. No harm results from the addition, and some operators prefer to always add the alcohol and water. With a very obstinate paste which settles very slowly, or indeed refuses to settle clear after considerable time, it is usually best to start afresh and use ether in place of the first addition of gasoline, and sometimes ether may be used to advantage throughout.

There is considerable evidence that the rapid settling of the pigment is a question of the hydration. During the grinding the mills usually become quite warm, and the tendency is to dehydrate both the sulphate of calcium and the clay, both of which are almost universally present in greater or less amount in freight car color. Alcohol containing small amounts of water is slightly soluble in gasoline, and its presence, therefore, facilitates the transfer of the water to the pigment. Also commercial ether contains small amounts of water, and this is apparently transferred to the pigment in the same manner. With some paints a coagulation of the pigment in flakes, and almost immediate tendency to settle, follow the addition of the alcohol and water, or the use of the ether.

It should be stated, that, notwithstanding all precautions, it sometimes happens that some extremely fine portions of the pigment refuse to settle, even after a day or two, leaving a slight tint or opalescence in the liquid. No

method is known of overcoming this difficulty, but it is believed that the error resulting does not exceed a small fraction of one per cent.

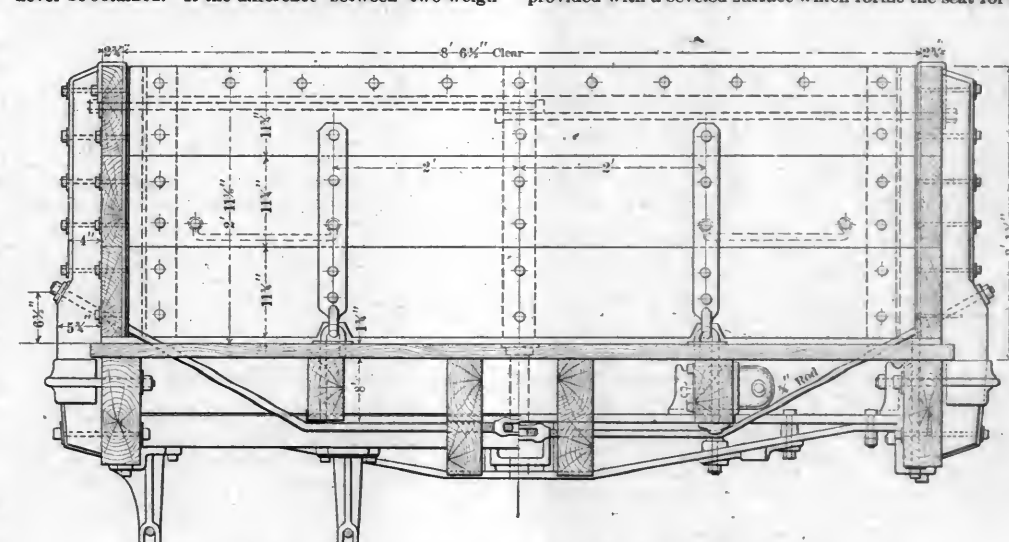
If the paste contains 25 per cent. of oil, as is desired and expected, the amount of oil in five grammes would be 1.2500 grammes. About 150 cubic centimeters of liquid is present before the first decantation, and by the supposition five one-hundred and fiftieths of this are left after the decantation is finished. That is $(1.2500 \times 5 \div 150) = 0.0416$ gramme of oil are left. But if the directions are followed, five one-hundred and fiftieths of this are left after the second decantation, that is $(0.0416 \times 5 \div 150) = 0.0013$ gramme of oil are left with the pigment and weighed with it. This amounts to an error of $(0.0013 \times 100 \div 5) = 0.026$ per cent. If greater accuracy than this is desired, a third treatment with gasoline can be employed.

The separation of the liquid from the pigment by decantation is much better than to use a siphon. Formerly a siphon was employed, but it was found that there was a little loss due to material adhering to the siphon, and also the liquid could not be drawn off so as to leave as small a volume behind, on account of the currents at the inlet end disturbing the pigment.

It is probable that there is a slight oxidation of the oil during the evaporation and subsequent drying to constant weight. Direct experiments on oil free from moisture, however, show that the change in weight due to this oxidation is very small. Milder has shown that during exposure to the air, especially at high temperatures, linseed oil loses carbon and possibly hydrogen, while it gains oxygen, and experiments made for the purpose show that the loss and gain very nearly balance each other, so that the error introduced during the drying can safely be ignored.

The directions require that both the oil and pigment be dried until constant weight is obtained. It is probable that, especially with the oil, absolute constant weight would never be obtained. If the difference between two weigh-

ings an hour apart does not exceed one or possibly two milligrams, the resulting error will be small, as is readily seen, as to have no practical importance.



Improved Method of Trussing Coal Car Sides—Chicago, Milwaukee & St. Paul Ry.

ings an hour apart does not exceed one or possibly two milligrams, the resulting error will be small, as is readily seen, as to have no practical importance.

The directions to put the paste low down in the flask during the weighing, and to prevent the liquid from touching the cork, are perhaps of more importance than would appear at first sight. The difficulty of avoiding loss while decomposing the paste, if it is near the top of the flask, is quite considerable, and the loss if the liquid touches the cork is much more than would be supposed.

Gasoline is quite sensitive to changes of temperature, and its vapor tension even at ordinary temperatures is quite considerable. If the flask is tightly corked, therefore, there is danger of loss of both flask and its contents.

If the pigment is fully hydrated, the amounts of pigment, liquid and moisture, or other volatile constituents are given by the method with all the accuracy that is necessary in the analysis of such a product as freight car color. But if, as frequently happens, the pigment is not fully hydrated, it is evident that benzine, turpentine or some other volatile substance, could be added equal in amount to the lack of hydration of pigment, without this fact being revealed by the method as described. In cases where such additions are suspected, their presence or absence is determined by other tests, especially by distilling over the volatile constituents from a portion of the paste and examination of the distillate. The temptation to put volatile constituents into a paste is not very great, however, since, as stated above, owing to the heat of the mills, the loss of such volatile constituents during grinding would be quite considerable.

On the Halberstadt-Blankenburg Railway in Germany graphite is used successfully for lubricating the inner vertical faces of the outer rail-heads on curves. It is ground very finely and mixed with just enough water to form a thick paste, and when applied to the rails dries quickly, and the thin layers formed adhere a reasonable time to the

An Effective Truss for Coal Car Sides.

The trussing of coal car sides to prevent their bulging under the pressure from the load is a problem that has seldom been settled satisfactorily. It was made the subject of a report by a committee to the Master Car Builders Association in June, 1895, but the methods recommended for strengthening the sides did not appear to meet with approval, either because they were considered ineffective or because they were patented and therefore could not receive the official endorsement of the association.

In the accompanying illustration we show a method in use on the Chicago, Milwaukee & St. Paul Railway, which appears to us to be very neat and effective. We are indebted to Mr. J. N. Barr, Superintendent of Motive Power, and Mr. Geo. Gibbs, Mechanical Engineer of the road, for our drawings and information. It will be seen that the stakes are secured to the side sills in the usual fashion, but at a point about 6½ inches above the floor are provided with a beveled surface which forms the seat for a

nut and washer on the end of a truss rod that passes through the stake and down under the intermediate and center sills and up to the stake on the other side. The truss rod is made three-quarters inch in diameter and is provided with a turn-buckle at the center. Saddles are provided under the intermediate sills which may be in the form of castings or simply an angle iron secured to the corner of the sill.

This construction has the advantage of not encroaching on the coal space in the car, and not being in any way attached to the side sills it counteracts the tendency of the load to push or "roll" them out, an evil which most methods do not overcome. It is simple, and has been found to be quite effective. In cars 34 feet long inside, and with sides 3 feet high, four of these trusses are employed. In addition to the trusses and the fastenings at the end boards or gates, the sides are further held by straps on the inside, bent over at the top and terminating at the bottom in bolts which pass through the side sills. These are also shown in our drawing, and form a construction well known to our readers. Those seeking a remedy for bulging sides of coal cars might do well to give the method of trussing here shown a trial.

Convenience and Efficiency of Locomotive Design.

The following very sensible suggestions on this subject are made in an article written for the *Railway Herald*, the author of which signs himself J. H. Jenkins, Engine Driver, Swansea Dock Railway:

"The object in writing the article," he says, "is to point out that the things which are of vital importance to drivers and firemen for the proper manipulation of the machine such as the convenient position of tool boxes, sand boxes, brakes, levers, etc., are left to look after themselves. Indeed, things which appear to be mere trifles to designers, are, if not convenient and efficient, 'mountains of vexation' to the men."

"Of course, we are progressing in many things, but we

are too slow. It seems that once we get into a slovenly way of working, use becomes second nature, and we stay there until by mishap—sacrifice of limb, life, and property—some important change is forced upon us. As a proof of this small-like progression, look how we bore the wet sand-box for years, notwithstanding the terrible risk. Why, it makes one shudder to think of the poor fireman out on the leading end on a dark, stormy night, holding on for his life with one hand and sanding with the other; the rain on one side beating through his clothes to his very skin; the heat of the smoke-box on the other, scorching him, to say nothing of an

Back of the coal space the tank is perfectly plain, with no "dickey." The manhole is placed well back, and grabirons are placed across the back and along the sides. The hood contains good tool boxes over each water-leg, and the triangular space between the back slope sheet and the top of the tank is also utilized for a tool box four feet long, and with a door 12 inches by 36 inches, accessible from the top of the tank, as shown.

The sides and back of the tank are braced with tee-iron. The slope-sheet is substantially supported. No dashers are used, and they have not been found necessary. The tank is 19

rest on the top of the gage glass fitting, and prevents the india-rubber getting out of shape (see Fig. 2). This Mr. Webb states, results in the conical packings lasting very much longer, and also gets rid of a good deal of trouble which was previously experienced with the india-rubber rings before they were protected.

Comparison of Mechanical Draughts.

FROM A PAPER READ BEFORE THE INSTITUTION OF ENGINEERS AND SHIPBUILDERS IN SCOTLAND, BY MR.

JOHN THOM, M. I. N. A.

I have been led to choose this subject through having crossed the Atlantic three times in an official capacity, and each time in a vessel fitted with a different arrangement of mechanical draught.

My intention is to mention the results obtained from the arrangements adopted in these vessels and other systems that have come under my own supervision, and it will be instructive if other members will give their experience with any other arrangements.

The systems I took notes from were:

First.—The closed stoke-hole, usual Admiralty system, funnels covered over and air-forced into the stoke-hole with fans, and air-locks for allowing men to enter and go out.

Second.—The well-known Howden system of forced draught, with the air heated on the way to the furnaces by the hot gases as they pass to the funnel.

Third.—The Ellis and Eaves arrangement of induced draught, with the air heated on the way to the furnaces, similar to Howden's system, but the fans in this instance are placed at the base of the funnel, and induce the gases to them (will be spoken of as suction draught in this paper).

Fourth.—The closed ash-pit arrangement, with fans discharging direct to the furnaces, and stoke-hole gratings open.

A. The first arrangement mentioned, the closed stoke-hole, is still working satisfactorily after many years' use, and does not appear to injure the boilers as it is worked. The air pressure carried is $\frac{1}{2}$ -inch in the stoke-hole, burning 25.9 pounds of coal per square foot of grate, and giving 18.1 indicated horse power per square foot of grate, and .372 indicated horse power per square foot of heating surface.

The result of a good passage with very good American coal was 1.6 pounds of coal per indicated horse power per hour with American coal the full power developed is only about five per cent less than the Welsh coal.

This system is very simple; although the air-locks are inconvenient, and all the bunkers require to be air-tight, as the air would escape from the stoke-hole through them, as the bunker doors must always be left open (if there is any leakage the coal dust will be blown on deck). The inconvenience of air-locks is not so much felt in a large steamer, where the engineer remains a full watch in the stoke-hole. The stoke-hole is very dirty, especially with Welsh coal. The temperature of the stoke-hole was 116 degrees Fahrenheit, with the atmosphere at 62 degrees Fahrenheit mean of voyage.

B. Howden's, the second system, fitted in a sister vessel to the first, is a decided advantage in many respects. The stoke-hole can be left open to the engine room, and is much cleaner, there is not so much dust flying about. Care must be taken to make the uptakes and casings air-tight, or the arrangement is not so effective, as the gases escape into the stoke-hole. This arrangement is worked with a shorter fire bar and burning a greater quantity of coal per square foot of grate, owing to being able to carry a higher pressure at fires through having valves; for shutting off the draught while firing.

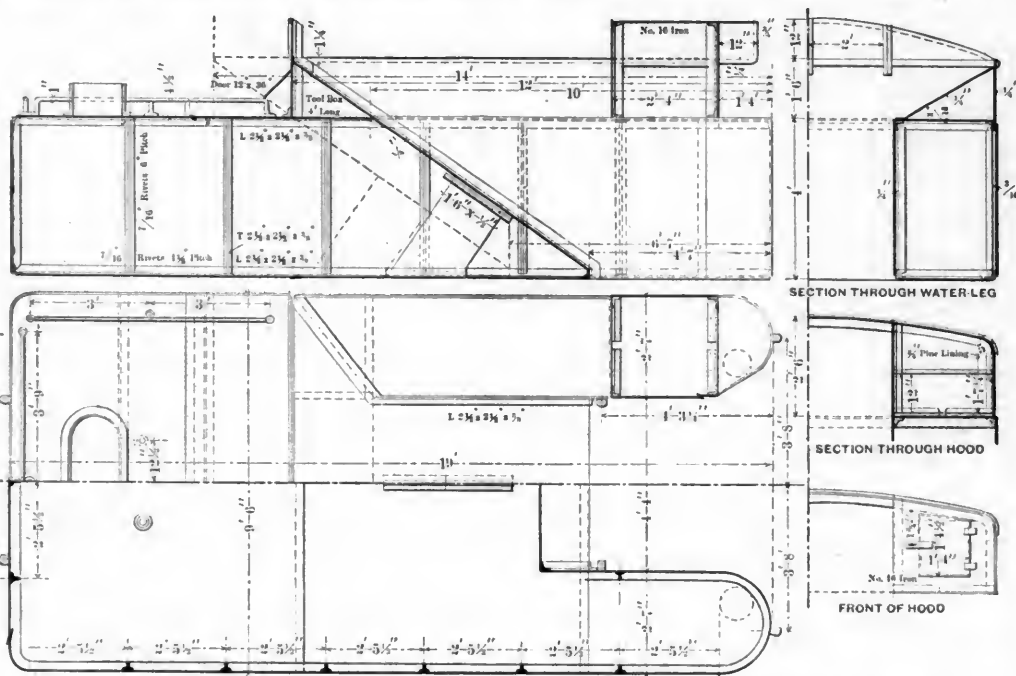
Of course there are more complications on the boiler front which require attention, but there is an average saving of about eight per cent. in the coal bill over the first system, due to the heated air and retarders.

This arrangement is not so suitable for American coal as it is for Welsh coal. The falling off in full power, due to using American coal instead of Welsh, is about twice as much as it is in the vessel with the closed stoke-hole. The temperature of the stoke-hole is about the same as it is with the closed stoke-hole, system—116 degrees, with the atmosphere at 61 degrees. Taking the results from a good voyage with Welsh coal, with $\frac{3}{4}$ inches air pressure at the fans, and $1\frac{1}{2}$ inches at the ash-pits, burning 28.2 pounds of coal per square foot of grate, that is with 18.6 I. H. P. per square foot of grate surface and .303 I. H. P. per square foot heating surface, the consumption is 1.52 pounds of good Welsh coal per I. H. P. per hour.

C gives the results from a more recent arrangement of Howden's system on trial. When indicating on trial 24.13 horse-power per square foot of bar surface and 5.77 per square foot of heating surface, the temperature of the funnel gases was 496 degrees and air entering fires at 150 degrees, and $3\frac{1}{2}$ -inch W. G. pressure of air at fans, the heating surface of air heating tubes equal about one-third heating surface of boiler.

D. The Ellis and Eaves arrangement is the latest system of mechanical draught, and has been developed at Messrs. John Brown & Co.'s, Sheffield, where they have a large number of boilers working under this system.

The combination of Howden's and Martin's systems with Serve tubes makes a comfortable arrangement. The stoke-hole is open as with ordinary draught—in fact, it is just ordinary draught intensified by the fans. The air before reaching the furnaces is drawn through horizontal air heating tubes. The hot gases on their way to the funnel pass round outside these tubes so that the air is heated, as in Howden's arrangement on voyage mentioned, to 308 degrees Fahrenheit, the air drawn from above the boilers entering the air tubes at 117 degrees, and at fan delivery or funnel base 395 degrees. The heating surface of air-heating tubes was about the same as total heating surface of main



Locomotive Tank with Sloping Bottom to Coal Space—Chicago, Burlington & Quincy R. R.

occasional red-hot cinder which had a way of landing, with devilish precision between the collar of his coat and his neck.

"With regard to tool-boxes being placed on the back of the tenders, and the number of men who are knocked off and mangled continually, it will be sufficient to observe that, like the Armenian atrocities, we are getting used to them.

"These things cast a sad reflection upon our 'big ones,' and it is to be earnestly hoped that the *Herald*, which has always cast its strong rays of light into many dark places of railwaydom, may again be the means of bringing about a speedy change in these things also.

"We now come to a matter which is of the utmost importance to engineers, and which really is the main object of the writer—i. e., the gage-glass. It has been the practice for many years, and is now to a great extent, on the London & North Western Railway, to connect the steam-gage pipe to the top cock of the gage-glass. Now the folly and disadvantage of this arrangement is apparent, even to the most superficial observer. In the event of the steam-gage failing, the gage-glass would have to be shut off too, and vice versa.

"Just think for a moment of the sorry plight of the driver and fireman who, on some rough night, have all they can do to get along; a glass bursts, perhaps when entering some important junction; after a minute or so of battling with the overpowering steam and water, the cocks are shut off. Now, it is a trial in itself to have no means of ascertaining the level of the water in the boiler; but the trouble in this case is that the steam-gage is now no longer in communication with the boiler; consequently they have to get along without both, or until an opportunity occurs on the road to put one in. True, there are try cocks, but these are usually such paltry things that they often get neglected. Then, again, the automatic cocks which are fitted to many of this company's engines, though independent of the steam-gage, are not efficient; in fact, there are many instances where trains have had to be given up through these cocks failing.

"In my humble opinion, all boilers should be fitted with two automatic gage-glasses, independent of the steam-gage, and so constructed that, in the case of failure, they could be shut off by hand. I have used them, and speak from experience, and can testify to the convenience and efficiency of such an arrangement."

Locomotive Tank with Sloping Coal Space—Chicago, Burlington & Quincy Railroad.

The Chicago, Burlington & Quincy Railroad put in service some months ago several locomotive tanks so designed that all the coal carried would come down within reach of the fireman by the action of gravity. Our illustrations show the construction clearly. The coal space has a sloping back which extends to a point 18 inches above the top of the tank and 24 inches back of the junction of the slope sheet with the top plate. No coal is carried on top of the tank back of upper termination of this slope. The tank is provided with a hood which extends 3 feet 8 inches back from the front ends of the water-legs, and back of the hood there are sloping sheets riveted to the inside top edge of the legs and to vertical extensions of the side sheets. Thus all coal carried over the water-legs will slide down into the coal space as the latter is partially emptied.

feet long, 9 feet 6 inches wide, and 4 feet high. The coal space is 4 feet 4 inches wide, and 18 inches higher than the rest of the tank. These tanks have been built in two sizes, the second of which is shown in dotted lines. As shown in full lines they hold 4,300 gallons of water and seven tons of coal. With the enlarged coal space the water capacity is 4,040 gallons and $8\frac{1}{2}$ tons of coal. The tanks have a very neat appearance.

Protection of Water Gage Glasses.

Mr. F. W. Webb, of the London & North-Western Railway, proposes the use of a spiral wire spring encircling glass tubes, as shown in the engraving in Fig. 1 as a protection to men from the breaking of such tubes. The spring forms a good support or backing to the glass, and when breakage

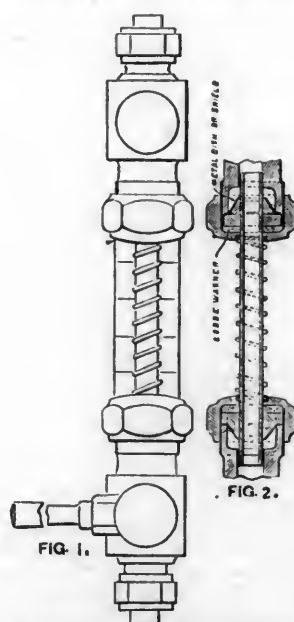


FIG. 1.

FIG. 2.

A Protection for Water Glasses.

occurs holds the pieces together and prevents them scattering. It is also claimed that the spring maintains the glass at a more uniform temperature. In the event of fracture the glass is easily removed by slightly compressing the wire spring, which can then be removed from the recesses in which it fits at the ends.

Mr. Webb also refers to another little improvement in the packing for the glass and which consists of a conical brass shield, now commonly used for high-pressure gage glasses. This ring is flanged on the outside so as to

boiler, or three times greater in proportion than Howden's arrangement. There is, however, this advantage: the furnaces are under less pressure than the stoke-hole, and a certain quantity of cold air can be allowed to enter from the stoke-hole below the fire-bars. This sweetens the air in the stoke-hole, as the air that is taken away is replaced by pure air from above, and any leakages about the furnace fronts or casings act in the same way, drawing in air. The temperature of the stoke-hole was only 80 degrees. A certain amount of cold air admitted under the fires does not appear to affect the economy much.

From experiments made at Sheffield, it was discovered that by raising the firebars a few inches at the back (instead of lowering them at the back in the usual way) the bars would allow the fires to be forced very much more severely and would give no trouble when burning over 60 pounds of coal per square foot of grate. Sloping the bars up toward the back has a further advantage, that it is easier to see that the whole of the grate is covered through the fire-door, and there is no chance of the flame being blown in your face. Another advantage the arrangement in this vessel possessed was the control the engineer had of regulating the quantity of heated air admitted above and below the bars, with peep-holes to watch the result, while regulating. With bituminous coal all the hot air would be put over the fires and the smoke almost entirely consumed.

The consumption per indicated horse power (on voyage) of which particulars are given, was 1.41 pounds per hour with soft coal (not South Wales coal), which equals .539 I. H. P. per square foot of heating surface, and 17.13 I. H. P. per square foot of bar surface, and 24.2 pounds of coal per square foot of grate, with 3/4-inch W. G. vacuum at fan and chimney, and 1-inch W. G. vacuum at ash-pit.

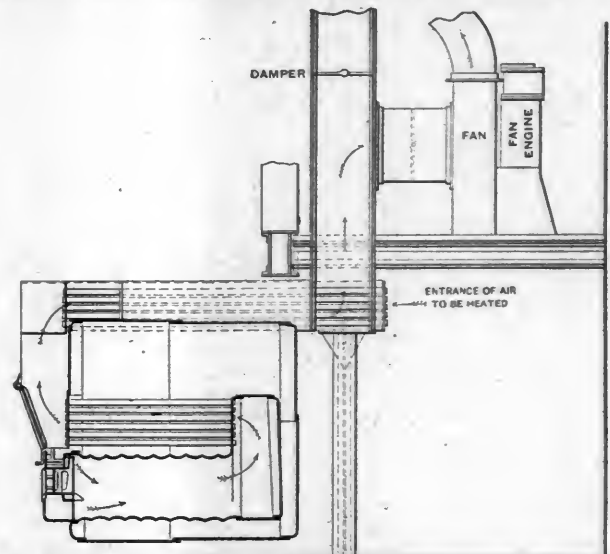
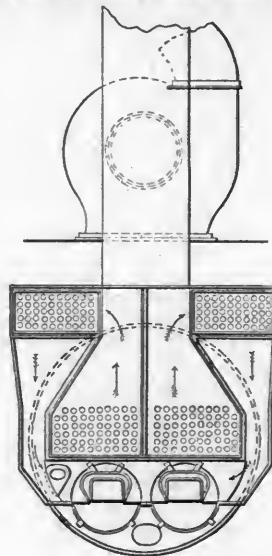
I should mention that in firing and cleaning fires, the action of opening the door automatically closed off the draught from the furnace and prevented the cold air from rushing in. At Sheffield they think this an unnecessary precaution, and I do not think it is adopted there. They hold the opinion that with suction draught the heat impinging on the ends of the tubes and tube-plates is altogether different to what it is with forced draught. The adherents of suction draught say it sweeps clear of the ends of the tubes and enters in the center, while with forced it impinges on the tube ends. Many other engineers maintain that the action is precisely the same in each case; the draught is due to difference of pressure at the base of the funnel and at the furnace mouth.

From experience at Sheffield they advise the air space at the back of furnace between the bars to be reduced, as the draught is more intense at the back end of grate.

The fans are about double the capacity in the suction ar-

hour, with 1 1/2 inches air pressure at fans. This arrangement has also been working satisfactorily for years.

The results given are from a similar arrangement to that so well worked out by Mr. D. J. Dunlop, Port-Glasgow, and published in *Engineering*, March 18, 1892, fitted in the yacht *Mira* which had the exciting race from *Cloch* round the Cumbraes with the yacht *Hermione*. This was a private tussle—closed ashpit versus Howden—and



The Ellis and Eaves Arrangement for Induced Draught.

ended in a victory for the closed ashpit by several minutes. Both yachts were designed by the same naval architect.

I annex a sketch of Ellis and Eaves' combination. The other arrangements are so well known that sketches are unnecessary.

The sketch shows the arrangement as adopted for land purposes at Sheffield. For marine work I think it would be advisable to draw the air through outside the tubes, and let the coal gases pass through the tubes; they could then be swept when overhauling in port from outside the heating-box, same as boiler tubes.

In further reference to the table of comparisons annexed, the first two refer to mail steamers kept continually work-

tained from any of these systems, showing a greater power obtained from the coal or from the weight, but the examples I have taken are from vessels under or about the same conditions for a fair comparison.

On trial, in the instances mentioned, the closed ashpit arrangement is much superior to all the others in indicated horse power per ton of machinery, and Ellis and Eaves' system shows the most power per square foot of heating surface on

COMPARISON OF MECHANICAL DRAUGHTS.

	A Closed stoke-hole system.	B Howden's system.	C Howden's system.	D Suction system.	E Closed ashpit system.	F Natural draught system.
Engines and working pressure....	Triple, 160 lbs.	Triple, 160 lbs.	Triple, 180 lbs.	Quadruple, 200 lbs.	Triple, 170 lbs.	Triple, 165 lbs.
I. H. P. per square foot of grate—trial.....	16.1	18.6	21.13	21.7	22.66	14.73
I. H. P. per square foot of grate—voyage.....	16.1	18.6	16.96	17.13	13.3	10
I. H. P. per square foot of heating surface—trial.....	.....	.....	.577	.682	.714	.5
I. H. P. per square foot of heating surface—voyage.....	.372	.393	.405	.539	.418	.346
I. H. P. per ton of boiler and appurtenances—trial.....	.....	.....	16.8	14.7	19.6	15.9
I. H. P. per ton of boiler and appurtenances—voyage.....	13.71	13.71	11.8	11.6	11.51	11
Length of firebars.....	6 ft.	5 ft. 3 ins.	5 ft. 3 ins.	5 ft. 9 ins.	6 ft.	5 ft. 6 ins.
Pounds coal per square foot of grate—voyage.....	25.9	28.2	25.3	24.2	20.7	15.4
Pounds coal per I. H. P. at time cards were taken.....	.....	.....	1.4	.....	.....	.....
Pounds coal per I. H. P. per hour, mean of voyage.....	1.5	1.52	1.51	1.41	1.56	1.53
Quality and purpose used for.....	American, very good; used for propelling machinery only.	Welsh, good; used for propelling machinery only.	Soft coal; used in main boilers for all ship's purposes.	Soft coal; used in main boilers for all ship's purposes.	Welsh; used in main boilers for all ship's purposes.	Soft coal; used in main boilers for all ship's purposes.

angement of draught compared with the other arrangements, due to the gases having expanded by the heat, and the gas from the coal burned having to pass through the fans. Although double the capacity, the adherents of suction draught maintain the fans do not require double the power, as the work done is much the same, whether you put the power at either end of the conduits, but the fans, being larger and heavier, have more friction, and are said to require 25 per cent. more power to work them in handling the lighter gases.

E. The Closed Ashpit System is the fourth arrangement mentioned. Although, perhaps, the oldest, this is the least adopted, through the fear of using cold air under a high pressure. The arrangement works very well if properly designed. You can get a very high power from a light boiler, but you must take the precaution not to inject the air directly into the ashpit; only arrange it so that the air is circulating all over the furnace front, and let pressure into the furnace at various parts above and below the bars.

The stoke-hole is quite open in this system, and it has this advantage over all the others, that you have merely to open the ashpit doors and stop the fans in order to work with natural draught. The fans draw from the engine room or stoke-hole, as desired, and keep the engine-room and stoke-hole more comfortable than with natural draught. You will notice from the table that with this arrangement the power on trial was very high for the weight and heating surface—22.6 I. H. P. per square foot of bar surface and .714 per square foot of heating surface, with 4 inches air pressure at fans and 2 inches at ashpits.

Under ordinary cruising conditions the power was reduced to 13.3 pounds of coal per square foot of bar surface, and .418 I. H. P. per square foot of heating surface. The consumption was 1.56 pounds of Welsh coal per I. H. P. per

ing at full power. They are exactly the same in every respect, except the system of draught employed. These two steamers when working under favorable conditions, the closed stoke-hole made the fastest passages with American coal and the Howden system the quickest with Welsh coal, but latterly the closed stoke-hole is quicker, taking all last season on an average, of six hours per passage. This vessel was not designed to suit Howden draught originally, but the boilers were designed to suit forced draught. The average consumption of average voyages with Welsh and American coal takes 10 per cent. more coal per indicated horse power than mentioned in table. The furnaces with the closed stoke-hole arrangement stood quite as well as with Howden's draught, but the tubes began to leak at combustion chamber end, and her boilers had to be retubed at a much earlier date than with Howden's draught.

Altogether, it is a very creditable result for the Admiralty system where you can afford to carry weight for engines large enough for economical working with a good number of expansions.

The indicated horse power per ton of boilers and machinery is almost as great in these two express vessels on ordinary work as the others on trial. This is where the human element comes in. The indicated horse power per ton of machinery is very nearly alike in the other examples.

The second two refer to swift cargo steamers of the same type.

The fifth column refers to a yacht of 1,500 indicated horse power, showing that a large horse power can be obtained with this arrangement when necessary. With it natural draught can be adopted, and save the decks from the discharge of ashes caused by forced draught.

Generally, I have no doubt that examples might be ob-
voyage. This should be expected, as it is the only one fitted

with Serve tubes, but I do not think the full advantage of these tubes has yet been taken in designing boilers. I have advised in boilers now building to reduce the number of tubes. In that way we get larger furnaces, and greater power from the same dimensions of boiler, and depend on the heat absorbing power of the Serve tube to make the heat distributing furnace more effective. The Serve tubes will be worth paying for under these conditions. Howden's arrangement shows the greatest power per square foot of grate both at trial and on voyage, due to using shorter firebars.

From my own experience I know that each of the systems can be made to work very satisfactorily. The furnaces will not give trouble with any of these systems so long as the air is properly admitted, although, naturally, one would be led to suppose that the heated air would do the furnaces less damage.

The most economical arrangements are the heaviest, probably because of the air-heating tubes which are employed in these systems. When the length of voyage is limited it becomes questionable whether the increased economy is worth obtaining when it is necessarily accompanied by increased weight. But in the case of a long voyage the smaller consumption will necessitate less coal to be carried, and so the total weight of boilers and coal will be less than when lighter systems are employed.

The fans themselves are the most important factor of any forced draught system. When the fans are too small they have to be overdriven, and soon come to grief. I have found that a good empirical rule for the capacity of the fan is—
Width at periphery × dia. × circ., all in feet

= cub. ft. of air per rev.

Allow for 250 cubic feet of air per pound of coal to allow for leakages, etc. Of course you will require to see that the speed of the fan periphery is suitable for the amount of air pressure to be carried, say—

$8 \sqrt{68 \times \text{inches water gage air pressure}}$
= speed of fan tips in feet per second to balance inches water; multiply by 60 and divide by circumference of fan in feet = revolutions of fan per minute for forced draught.

If you leave the proportioning of the fans to the fan-makers they are apt to supply fans which are much too small for the work required, in order to reduce the price.

If the fans are over double the capacity given by this rule they can be depended upon to work in the funnel glass after they have been reduced in temperature by the air-heating tubes.

These air-heating tubes have been the saving of the induced system. When the fans are put direct in the funnel, as originally fitted, it is quite probable that you might find only the stumps of the blades left after the trial when consuming a large amount of coal with small heating surface.

Another decided improvement was that adopted by Messrs. J. & G. Thomson in the vessel from which the particulars are given, namely, in placing the fans on brackets on the casing of the vessel instead of on the hot uptakes, which soon heat up the fan base.

I should mention that all the arrangements mentioned are now fitted with retarders except the natural draught example. This seems to be an important factor in the economy derived from forced draught.

Some owners think it a greater invention than that of the triple-expansion engines, because, fitting it to some of their steamers when the conditions were favorable, the saving was as much as 10 per cent. of coal.

I should mention the consumption of coal per indicated horse power is arrived at by reducing the indicated horse power calculated from the diagrams at the revolutions the engines were then working, to the power equal to the mean revolutions from the counters on the voyage as the cube of the revolutions and the total coal consumed between ports, according to the American navy practice.

A friend proposed to add the particulars from a good modern ordinary draught steamer to the table for comparison at F; this I have done. All the steamers have the same style of feed-heater except E, which is not fitted with one.

(Established 1832.)

AMERICAN ENGINEER CAR BUILDER AND RAILROAD JOURNAL.

27th YEAR.

65th YEAR.

PUBLISHED MONTHLY

BY

R. M. VAN ARSDALE,

MORSE BUILDING.....NEW YORK.

M. N. FORNEY,
W. H. MARSHALL, } Editors.

F. H. CLARKE, Advertising Manager.

APRIL, 1896.

Subscription.—\$2.00 a year for the United States and Canada; \$2.50 a year to Foreign Countries embraced in the Universal Postal Union.

EDITORIAL ANNOUNCEMENTS.

Advertisements.—Nothing will be inserted in this journal for pay, EXCEPT IN THE ADVERTISING PAGES. The reading pages will contain only such matter as we consider of interest to our readers.

Special Notice.—As the AMERICAN ENGINEER, CAR BUILDER AND RAILROAD JOURNAL is printed and ready for mailing on the last day of the month, correspondence, advertisements, etc., intended for insertion must be received not later than the 25th day of each month.

Contributions.—Articles relating to railway rolling stock construction and management and kindred topics, by those who are practically acquainted with these subjects, are specially desired. Also early notices of official changes, and additions of new equipment for the road or the shop, by purchase or construction.

To Subscribers.—The AMERICAN ENGINEER, CAR BUILDER AND RAILROAD JOURNAL is mailed regularly to every subscriber each month. Any subscriber who fails to receive his paper ought at once to notify the postmaster at the office of delivery, and in case the paper is not then obtained this office should be notified, so that the missing paper may be supplied. When a subscriber changes his address he ought to notify this office at once, so that the paper may be sent to the proper destination.

The paper may be obtained and subscriptions for it sent to the following agencies: **Chicago**, Post Office News Co., 217 Dearborn Street. **London, Eng.**, Sampson Low, Marston & Co., Limited, St. Dunstan's House, Fetter Lane, E. C.

The experience of the New York Central road with extended piston rods for locomotives has been so favorable as to make reasonable the belief that the saving in wear of cylinders and pistons more than compensates for the expense and maintenance of the additional parts. The extended rods have been fitted to quite a number of the heavy 19-inch passenger engines hauling the Empire State and other fast trains, and as these engines come into the shops for general repairs their cylinders have been examined and in a number of cases it was not found necessary to do any work on them, they being sent out untouched for another two years of hard running. Engine No. 870, well known for its regular work on the Empire State Express made 167,176 miles while out of the shop and the wear of the cylinders was less than $\frac{1}{16}$ of an inch. Officials from other roads have been impressed by the record made and it is possible that extended piston rods may be used more extensively on heavy engines in this country and viewed more favorably by railroad men than heretofore. The packing used in the case cited above consists of three cast-iron spring rings.

The use of a heavy anvil supported on springs in connection with a drop-testing machine, as illustrated on another page, is a genuine and truly scientific improvement of a machine that has heretofore been somewhat crude. A drop of 1,640 pounds falling from a given height has a fixed amount of energy stored in it, but the force of the blow given to the object on which it falls depends upon how suddenly its motion is arrested. If neither the object nor the foundation under it yielded in the least the force of the impact would be infinite, but with the smallest "give" the force of impact comes within the domains of the finite, and is rapidly reduced in amount as the yielding of the object increases. For this reason the weight of the anvil and the character of the foundations under it have had the effect of modifying the effect of the drop and making it difficult or impossible to accurately compare the results obtained from different machines or the same machine at different times. But by providing an anvil sufficiently heavy to take care of the force of impact without the aid of the foundations and then interposing springs that effectually prevent these foundations from having any influence whatever, the resistance to the force is made as constant as the force itself, and comparable results are obtained. The value of this improvement will we think be generally recognized.

The suggestions for the economical designing of timber trestle bridges sent out by the Forestry Division of the Department of Agriculture, and published in abstract elsewhere in this issue, will doubtless be read with interest by those concerned in the design and maintenance of such structures. The scaling down of the sizes of timbers at present used to conform to reasonable factors of safety, as determined by tests made under the supervision of the Forestry Division, cannot be objected to from a purely theoretical standpoint, but the impossibility of getting quickly the various odd sizes thus decided upon, the necessity of keeping many more sizes of timber in stock, and the greater difficulty of keeping track of the sizes needed for emergency work at any given trestle, all have had their influence in molding the practice of to-day and will have to be duly considered before any great change is made. But while there may not be unanimous approval of the suggestions of the Forestry Division, the general argument for economy of material in the construction of trestle is timely, particularly as engineers, with the results before them of the valuable and exhaustive tests and investigations made by the Division, are for the first time placed in a position where they can design such structures with an accurate knowledge of the strength of the materials employed. These valuable timber tests, as they are carried to completion for the different species of woods, will enable engineers to intelligently inaugurate economies. At the same time suggestions from the department on the practical application of results of the timber tests conducted by it, are next in importance to the tests themselves, for engineers as a class, in common with the rest of mankind, are none too quick to see the practical uses to which data obtained by scientific research can be put; the suggestions of the Department may not be followed to the letter, but they will certainly be prolific of good, in that they will induce engineers to make a more extensive use of the information than would otherwise be the case.

Before leaving this subject we would call the attention of engineers to the fact that though the tests have thus far cost only \$40,000, it is probable Congress, if left to itself, will fail to appropriate the small amount necessary to carry on the work for the fiscal year. If engineers and others will write to the Congressmen of their States urging upon them the value of the work and the wisdom of an appropriation, the funds will doubtless be forthcoming.

In specifying the physical qualities of boiler steel it is customary to designate a desired tensile strength and elongation, and to state the limits above and below these figures within which the manufacturer must work if his material is to be accepted. Thus, if the desired strength is 60,000 pounds and the elongation 25 per cent, the specifications would probably be so framed as to accept steel of a strength not less than 55,000 pounds or more than 65,000 pounds per square inch, with an elongation of 25 per cent. or more. Some such latitude is necessary or the specifications would be too rigid and cause needless trouble and expense. But with the knowledge that within certain limits, a reduction in the tensile strength of a given quality of steel permits of greater elongation and an increase in strength has a tendency to reduce the elongation, it is apparent that a manufacturer who furnishes a steel of more than 60,000 pounds strength and 25 per cent. elongation is really producing a better material than called for in the specifications, while if its strength is less than 60,000 pounds without greater elongation, it is inferior. Consequently, if a road wishes to get an equally good steel for all strengths within the limits specified, and yet not demand from the manufacturer more than it is entitled to, it should require a greater elongation in the lower part of the scale of strengths and be content with less elongation in the upper half of the scale. The Pennsylvania Railroad has met this point very nicely in its specifications by requiring that the product of the tensile strength and elongation shall not be less than a certain figure. For shell steel the specifications say: "These plates will be rejected if the test piece shows: 1, A tensile strength of less than 55,000 pounds per square inch; 2, An elongation less than the quotient of 1,400,000 divided by the tensile strength; 3, A tensile strength over 65,000 pounds per square inch; should, however, the elongation be 28 per cent. or over, plates will not be rejected for high strength." For fire-box steel the corresponding clause reads: "These plates will be rejected if the test piece shows: 1, A tensile strength of less than 55,000 pounds per square inch; 2, An elongation less than the quotient of 1,450,000 divided by the tensile strength; 3, A tensile strength over 65,000 pounds per square inch; should however, the elongation be 30 per cent. or over, plates will not be rejected for high strength." From this we see that if the strength of fire-box steel is 55,000 pounds the elongation must be at least 26.4 per cent. if 60,000 pounds, 24.1 per cent., and if 65,000 pounds, 22.8 per cent. This sliding scale of strengths and elongations is a neat way of providing for uniform quality, and is just and equitable to all concerned.

While the details of the various kinds of starting valves for two-cylinder compound locomotives differ considerably, the valves themselves may be generally divided into two classes—those which automatically change the engine from simple to compound working and are not under the

control of the engineer, and those which are non-automatic in the sense that the engineer can at will operate the engine as a simple one, either at starting or after the train is in motion. In the latter class the proportion of parts and passages is such that no additional power is obtained by working the engine simple except at low speeds. Of late the drift of opinion seems to be in favor of starting gears of this last mentioned kind, and there certainly appears to be some superior advantages in this method of construction. Many divisions of important railroad lines have limiting grades which decide the load which an engine can be assigned, this load of course falling far below what the engine can economically handle on the remainder of the run. If the operating and mechanical departments wish to increase the weight of trains hauled on such divisions in the interest of economy, it becomes necessary to build larger engines or use helpers. Assuming that larger engines are decided upon, these new locomotives, like the old ones, will be greatly underloaded on all but the hills. Now, if a road with such physical characteristics elects to build compound engines for this traffic, it will find that the style of starting gear employed may make some difference in the size of the engine. If the engine cannot be worked simple at the will of the engineer, it must be made powerful enough to take the maximum load over the heaviest grade while working compound; on the other hand if it can be worked simple with increased tractive power on the grade, the cylinders can be somewhat smaller, with the result of making them better adapted for working economically on the level; or to put it another way, with the same size cylinders the engine that can be made to work simple on the heaviest grades will not only take a heavier train over the division, but be better loaded for economy on the level portions of it. A tramp compound engine of the 10-wheeled type sent out by one builder, and tried on many Western roads, was capable of exerting about 18,000 pounds draw bar pull when working compound at slow speeds, but by throwing it into a simple engine the maximum drawbar pull rose to nearly 24,000 pounds, and several times this advantage enabled it to take trains over grades on which it otherwise would have stalled. These considerations have doubtless influenced opinion in favor of this type of starting gear, though it is apparent that the advantage mentioned would be of lesser importance on a practically level road.

THE MASTER MECHANICS' CONVENTION FOR 1896.

With the approach of spring the committee of investigation of this association, which were appointed at the meeting of the previous year, begin to bestir themselves in the preparation of their reports and the collection of data to be submitted to the coming meeting. At most other engineering associations the proceedings or "transactions" consist chiefly of papers written by members on subjects selected by themselves, and concerning which it is assumed they have some special information which is worth communicating to their fellow-members and the public.

The system which is followed in the Master Mechanics Association and its congener, the Master Car Builders' Association, and has been practised ever since they were organized, is somewhat different from the methods adopted by other analogous associations. At each meeting a committee is appointed to find subjects which it may be thought require investigation, and concerning which interesting and profitable reports might, could, would or should be made. The constitution of the Master Mechanics Association then provides that "when the committee on subjects has reported, and the association approved of subjects for investigation, the President shall appoint special committees to investigate and report on them, and may authorize and appoint a special committee to investigate and report on any subject which a majority of the members present may approve."

It is a sort of unwritten law of the association, that no member shall refuse to accept such an appointment, and it is usually regarded as a compliment to be placed on a committee of this kind.

This year the technical bill of fare which has been prepared is an unusually inviting one, and the committees appointed, with perhaps the exception of the tail end of No. 10, are of such a character that excellent reports may be expected from them.

To those of us who have been listening to reports read before this association, for a quarter of a century or more, some suggestions naturally occur. We recall the fact that the reports may be roughly though very discreetly divided into two classes—those which bore the audience to which they are read and those which don't. Now it may safely be said that as soon as the boring begins the profit ends, and when the listeners begin to yawn they are no longer instructed. In a report which is intended to be read to an audience as miscellaneous as that which assembles annually at these conventions, the first thing to guard against is overstraining the attention of the hearers. It should be remembered that the attention which the listeners can or will give to a paper, report or address, is very limited and is soon exhausted. Probably, if they were entirely frank, most persons who have for any considerable time been attendants at the meetings of technical societies would admit that most of the papers and reports which are read are

very tiresome. Unfortunately, most people think that what they have written will be, or should be, interesting to others. So inordinate is human conceit and vanity that few of us ever candidly consider whether if some one else had written what we have, and should read it to an audience of which we formed a part, we would be interested, instructed or wearied by it. Now, the other fellow, to whom we read our papers, is just as apt to be bored as we are when he reads his to us, providing neither of them contains food for instruction or overpasses our capacity for consuming and digesting it.

In mechanical construction we always keep in mind the limit of elasticity of the material used before we load or strain it. If we are wise, we will consider the elastic limit of an audience before we impose too great a natural strain on the attention of those who compose it.

There is another reason too why reports prepared for the Master Mechanics' and kindred associations should be limited in length. Their purpose is generally to present the various aspects of the subject, so that it may be intelligently discussed after the report is read. If an audience is tired out by listening to a too lengthy dissertation there will not be sufficient mental power left to carry on a profitable discussion. To call out a good debate of a subject at such meetings, it is therefore of the utmost importance that the report should be brief and terse and that the facts, principles and deductions should be presented so that they can be readily grasped by the hearers. If the treatment is rambling, loose-jointed and discursive, those who compose the audience are apt to fall into a sort of mental disintegration, and a motion is apt to be made that "the discussion be closed" and an extinguisher is thus put on the whole matter.

The following are the general subjects on which reports are to be made at the Master Mechanics' Convention this year:

1. Exhaust Nozzles and Steam Passages—Continued.
2. Counterbalancing Locomotives.
3. Slide Valves.
4. Reciprocating Parts.
5. Cylinder Bushings.
6. Hub Liners.
7. Steam-Pipe Joints.
8. Driving-Box Wedges.
9. Steps and Handholds.
10. Truck Swing Hangers.
11. Locomotive Grates.
12. Thickness of Engine-Truck Wheel Flanges.
13. The Apprentice Boy.
14. To Harmonize Standards.

The regular hours for the sessions are from 9 a. m. to 2 p. m., the meetings being continued for three days, so that altogether 15 hours are devoted to the business and the transactions of the convention. Besides the reports on these subjects, there will be the opening exercises, the address by the President, reports of Secretary and Treasurer, and a considerable amount of routine business, which is quite sure to consume from two to three hours of the first day's meeting. From 10 to 1 o'clock on each day is usually devoted to the discussion of questions propounded by members. The election of officers, and other business usually consumes at least another hour, so that nearly half the time of the convention is occupied with business outside of the reports of the committees on technical subjects. There is therefore only from seven to eight hours left for their reading and discussion. As there will be 14 of them this year, there will be on an average, barely a half hour, which can be devoted to the reading and the discussion of each.

Last year* we made a rough estimate of the total cost of holding one of these meetings, which indicated that it was somewhere from \$50,000 to \$100,000. The ultimate purpose of this expense is to bring the members together for 15 hours to deliberate on the subjects which were selected a year ago and have been enumerated above. Each hour of this time therefore costs somewhat more than from \$3,000 to \$6,000, and the cost of the minutes is from \$50 to \$100, and the value of the seconds is nearly \$1 to \$2 each. It will therefore be seen how extremely expensive a wind-bag is or a number of them are on such occasions. Obviously economy of time is of the utmost importance, and a lengthy report is out of place. None of them should take more than fifteen minutes to read, and if they were confined to five or ten would be better. If the material collected by any of the committees is of such a character that it cannot be condensed so as to be read in that time then whatever would be excluded should be submitted with the reports in the form of appendices, to be printed, but not read, the committee giving only, in a general way, the methods and results of their investigations. The prodigal sons at these meetings are the members who waste the time by rioting in talk, and

"Idly running on with vain prolixity."

In view of the expense which is incurred, and the consequent cost of the time devoted to the meetings, it would seem as though it might be a good plan to have placards printed and posted and reading somewhat as follows:

The cost of holding these meetings is from one to two dollars for each second of time devoted to its deliberations, from \$50 to \$100 for each minute, and from \$3,000 to

\$6,000 for each hour. Speakers are therefore requested to be as concise as possible and not waste the time, which costs so much, by observations not important or not relevant to the subjects under discussion, and it is suggested that each of them before speaking should calmly and interrogatively consider whether he would derive either entertainment or profit from listening to what he intends to say if it came from the mouth of another member.

There is, though, an obverse side to this view of the meetings, while the influences which detract most from their interest and profit is the loquacity of the bores and wind-bags, it is essential to the success of the meetings that those who are neither, and who are possessed of valuable experience, accumulated knowledge and of that kind of horizontality of mind which is of such great service to all of us in the perplexities and conduct of life, and who it may be, instead of being addicted to loquacity are disposed to be taciturn, should speak with the utmost freedom. Unfortunately no check-valve has ever been invented which will admit clear water to a boiler, but will close when that which is muddy is fed to it. An invention which would perhaps have still greater value, would be a sort of parliamentary check-valve, which would shut up the turgid speakers at meetings of deliberative bodies, and would open wide when a clear and pure stream of talk and thought is turned on. Many persons who are interested in the subjects which are to be reported on at the meeting which is now being discussed, would like immensely to learn what others know or think about some of them. It might not be a bad plan to request certain persons to consent to examination and cross-examination—after the manner which prevails in courts of justice—on some of the subjects in the above list. The writer confesses to an itching desire to cross-examine the Committee on Exhaust Nozzles and Steam Passages, and he would like to call some of the members of the Committee on Counterbalancing Locomotives to the stand with the privilege of asking questions to an unlimited extent, and probably no more interesting report could be made than that which might be compiled if the privilege were given to any one concerned in the subject to select certain members of the Association and ask them such questions as he liked with reference to whether it is safe to run pony trucks under fast express engines.

When a subject of importance is fairly brought before the Association, so that the members have a distinct comprehension of it, it is then of the utmost importance that discussion should in every way be promoted. If for a moment we consider the successive steps which have led up to this juncture, it will be seen how essential it is that nothing should interrupt the consideration of the subject which has thus been presented. In the first place, a year before the duty was imposed on a committee to select subjects for investigation. Having done this, another committee, who, it was assumed, were the fittest available persons for that task, was delegated with the duty of preparing a report, and during the year intervening they have given more or less time to the consideration and investigation of the matter submitted to them, and the Association has the right to expect that the committee will summarize all the available information and expense relating thereto which is accessible to them.

The members of the Association, who are fairly well paid men, give up their usual duties, travel hundreds or thousands of miles to attend these meetings, the purpose of which is to hear and consider such reports on subjects selected. A few hundreds of members there assemble together and are all avid and alert for information. A report is read under these circumstances. The Association may then be likened to a foundry cupola—it has been charged, the fire kindled, the blast turned on, and the metal is molten. The cupola is then tapped and the iron flows with vigor and brilliancy and could then all be drawn out and cast into useful forms. When at these meetings—to continue the simile—part of the metal has flowed out, a member who is not interested in the discussion will often rise and insert in the tap-hole a plug of cold clay, in the form of a motion that "the discussion be now closed." The motion is accepted, and the flow of discussion is then ended, and the molten thought which might have assumed useful form is allowed to cool and solidify in chaotic shape, and can then only be again brought to a fluid condition after much labor and time and heat has been expended on it. When an audience, having the knowledge, intelligence and experience which the members of the Master Mechanics' Association have, is prepared to hear and discuss a subject for the consideration of which they have come together, a sudden plugging up of the flow of mentality defeats the very purpose of their assembling together, and yet this is just what occurs over and over again through the action of some dull members who have, perhaps, not wit enough to be interested in or to comprehend the subject before the house. When the cupola has been heated the molds are ready and the metal molten, that is the time to draw it off and cast it into forms and objects which will be permanently useful. In other words, when an audience is assembled and is in an attitude of mind to deliberate on a subject, it is a waste of all the effort which has been made to bring it together to permanently stop the flow of ideas which are then fluid.

Quite a good many years ago it was suggested by Mr.

Coleman Sellers, whose absence from these meetings for so long a time is so much to be regretted, that every report made to a body like this Association should end with a recommendation or resolution embodying the conclusions of the committee which made the report. Such resolutions would be open for discussion, and by being distinctly formulated would help to lead and to keep debate within limits which would be relevant to the matters at issue. Most of the committees could not do better than to end their reports with one or more resolutions, which, of course, would be submitted for adoption or rejection by the Association. Such resolutions would then represent the consummation of the committee's work, and would briefly summarize their conclusions.

THE PROPOSED INTERNATIONAL STANDARD FOR SCREW THREADS.

The Swiss Government has invited European nations using the metric system of weights and measures to confer with it with the view of selecting and adopting a uniform gage for screws. As neither England nor the United States has adopted the metric system they have not been invited to participate in the councils of this convention. The decision of this conference will, nevertheless, be of great importance to the English-speaking nations. Great Britain already has a large foreign trade in machinery and manufactures that must ultimately be made to conform in detail measurements to metric standards, and American manufacturers, many of whom have been content for years with American markets, will eventually wake up to the fact that they must have foreign markets, if only to maintain a more even rate of production and minimize the effect on their business of the fluctuations in demand in the home markets. When this time comes we too will be concerned in metric screw threads and other standards which European manufacturing nations have adopted.

Fortunately for American manufacturers and engineers who are thus without representation in the decision of a matter which will some time be of such importance to them, the standard likely to be adopted is that of the French Admiralty. This gage closely resembles the Sellers threads, which are standard in this country. The shape of the French thread is identical with that of the Sellers, and the pitches for the various diameters closely resemble the Sellers, being on the whole somewhat finer, and each size being, of course, an integral number of threads per decimeter. If, therefore, we are ever required to adopt as our standard the decision of this convention, the new standard may be expected to conform closely to what the experience of our leading engineers and manufacturers have found to be desirable.

The time seems to be near at hand when international standards of measures and weights should be in effect in all civilized nations and not adopted by the few. This being the case, it would be fortunate if no action looking to the adoption of a standard of this kind would be taken without the co-operation of all. It may appear that in the selection of such a standard as metric screw threads, nations not at present using the metric system have no interests, but this is not so if there is anything in the idea that a uniform system of measurements is ever to be in force in all civilized nations. The earlier that all can have a share in the establishment of standards intended to be international, the sooner will the use of the standards become general.

The advocates of the metric system have urged upon the English and American public some so-called advantages of the system which can easily be shown to be a myth. The derivation of the unit of a system is of little or no importance, but the convenience of the sub-divisions of that unit and the extent to which the system is used, are of vital moment. We believe the convenience of the metric system and its general adoption in the countries whose markets American manufacturers and merchants will endeavor to enter or are even now striving to supply, will eventually lead to its adoption here. Great Britain and America cannot afford to use one standard of measures for home markets and another for foreign ones, and as the foreigners will not come to us, we will have to go to them in this matter. Even now the House of Commons in England has before it a measure to compel the adoption of the metric system in two years and there are rumors of a bill to be presented to Congress at Washington compelling the adoption of the same system in this country, by the year 1900. But it is questionable if such legislation will be enacted or if enacted will succeed in bringing about the desired result. Commenting on the English measure *Engineering* says:

As regards the possibility of carrying out the recommendations of the committee, we may say, in the first place, that it is very doubtful if the necessary standards could be prepared and verified in the time named. The manufacturers would probably contrive to produce the millions of measures of weight and capacity needed to replace those now in use, but unless the Government displayed unheard of activity, it is certain that the testing and stamping could not be done in that time. These matters, however, do not greatly affect engineers, as they seldom sell by lengths or weights, at least not in the sense that the shopkeeper does. Nevertheless, the change promises to provide them with troubles enough of their own to make them look forward to it with anxiety. It is one of those things every one wishes well over. That it will be enormously beneficial must be conceded by all. The time has gone past when it is necessary to furnish arguments as to the advantages of

*See *American Engineer* for July.

the metric system over our own confused methods. Those whose business it is to deal with foreign countries know best how much they lose when they come into competition with manufacturers from Germany and Belgium, from the inability or indisposition of other nations to comprehend the standards we follow. We regard it as an absolutely foregone conclusion that the metric system will be adopted here, and the only points open to discussion are how the transition can be made most easily, and how far can advantage be taken of the change to establish certain international standards, which would have great commercial value.

If the above sentiments correctly represent the opinions of English manufacturers, it will not be long before the United States must adopt the metric system or find itself alone in its opposition. If the change is once undertaken in the proper spirit it will probably prove less troublesome and expensive than expected, though it will be no trivial task.

The Tobacco Nuisance.

Our comments on the "abomination of expectoration" in cars and elsewhere, published in February, have called out the following letter from a correspondent:

I note what you say in your February number about the offensive habit which many people have of spitting on the floor in public conveyances or public places. The writer desires to thank you for your superlative utterances on this subject. I can endorse them all. But there is another intolerable nuisance which the suffering public has to bear, which is a more nauseous, execrable, offensive, odious, loathsome, horrible, detestable, foul, unwholesome, beastly and infectious practice than the other is or can be, and that is the intolerable nuisance of tobacco smoke, the long-suffering public has to bear as they travel in the crowded streets or congregate in public places. I, too, "am not a woman, nor the husband of one," but I am perfectly aware of the intolerable nuisance which tobacco smoke is to most women; but they have to grin (?) and bear it, because they cannot help themselves, and there is not more than one smoker in fifty who stops to consider whether their tobacco smoke is disagreeable to other people or not. The writer has a near friend who was at one time an inveterate smoker, but after a severe struggle gave up the habit, and now this same man tells me that he never knew before what an extremely selfish person he had been, and what a perfect nuisance he must have been for years by smoking.

Mr. Editor, Will you not kindly for the sake of women, as well as non-smoking men, who detest tobacco smoke, lend your pen to call the attention of selfish smoking men to the unmitigated nuisance they make of themselves, to the non-smoking part of the community, as they walk the crowded streets and burn incense to their idol. Can't we have a law in New York as they have in some other cities prohibiting any person from smoking in a crowded street? Yours for comfort and cleanliness.

EAST ORANGE, N. J.

R. A. HUTCHINSON.

The sentiments of our correspondent are those of the editor-in-chief of this paper. Similar opinions have also been held by—we were about to say—other distinguished men. Thus Dr. Oliver Wendell Holmes on being asked whether a young man should smoke, emphatically replied: "Certainly not. It is liable to injure the sight, to render the nerves unsteady, to enfeeble the will and enslave the nature to an imperious habit likely to stand in the way of duty to be performed."

Burton in the *Antony of Melancholy* says: "Tobacco, divine, rare, superexcellent tobacco, which goes far beyond all panaceas, potable gold, and philosopher's stones, is a sovereign remedy in all diseases. A good vomit, I confess, a virtuous herb, if it be well qualified, opportunely taken and medicinally used; but, as it is commonly abused by most men, which take it as tinkers do ale, 'tis a plague, a mischief, a violent purge of goods, lands, health—hellish, devilish and damned tobacco, the ruin and overthrow of body and soul."

Another old worthy named Sylvester, who wrote a book or an essay on "Tobacco Battered," says:

"Tobaccoing is but a smoakie play,
If their tobaccoing be good, how is't,
That lewdest, loosest, basest, polishes't,
The most unthrifty, most intemperate,
Most vicious, most debauched, most desperate
Pursue it most?"

The same writer also says:

"A tobaccoist, I dare aver,
Is first of all a rank idolater."

Again he says:

"Hell hath smoak,
Impenitent tobaccoists to choak."

Professor Reynolds, in an address delivered some years ago before the Hospital College of Medicine, said:

"It is a well-known fact that tobacco deranges the digestion and poisons the nerve centers of a majority of the male members of the human family. A species of blindness, not complete, but partial blindness, sufficiently great in extent to destroy the reading of ordinary type, results from the continued and excessive use of tobacco. Careful investigations have led to the discovery that that form of tobacco habit known as smoking produced the so-called amblyopia. This form of amblyopia is precisely identical in all respects with that produced from the excessive use of alcohol. Both are incurable.

"Smoking tobacco has never been known to result beneficially to any person in the world. It always lessens the sense of smell and taste; it always contaminates the breath; it always creates an unsteadiness of the muscles, through its irritating effect upon the nerves; and I know from personal experience it diminishes the capacity for mental labor."

The celebrated Dr. Döllinger said on the same subject:

"The eternal smoking of pipes and cigars by our fore-

fathers doubtless helped to bring about the short sight which has now become hereditary in Germany. Tobacco-smoking is the ruin of society and of chivalrous conduct towards women. The tone becomes less refined, conversation suffers from it. For a long time I have avoided any society where smoking is allowed, and often travel first-class in the railway solely to escape the disagreeable, unwholesome atmosphere."

At a meeting of the Anti-Tobacco Society, held in Manchester, England, some years ago, the statement was made "that careful statistical investigation has shown that teetotallers who smoke are five times more liable to fall away than those who do not."

Medical authorities are agreed that, taken in moderate quantities it calms restlessness and produces a state of gentle languor or repose; or acts as a harmless excitant and sedative, but "yet it is a frequent cause of paralysis when the practice is indulged in to excess. Oil of tobacco which is inhaled and swallowed in the process of smoking, is one of the most violent of known poisons. The Hottentots are said to kill snakes by putting a drop of it on their tongues, and the death of these reptiles is said to take place as instantaneously as if by an electric shock."

There have been occasions when we have been inclined to regret that this poison of tobacco was not as deadly to some smokers as it seems to be to venomous serpents. That the habit is attended with some risks is shown by the following tale told by the *British Medical Journal*. That paper says:

"A gentleman was ordered some ordinary chlorate of potash lozenges for a sore tongue, and for convenience he kept them loose in his waistcoat pocket, as scores of people have done before. Now, as ill-luck would have it, this gentleman also bought a box of Swedish safety matches, and these he also put into the same pocket. Now, a moment's consideration of what a safety match is tells us at once the whole catastrophe. To prevent matches going off of themselves the makers separate the ingredients, putting the phosphorus on the box and the chlorate of potash on the matches. While bending down to pick up something on the floor the lozenges rubbed against the friction paper on the outside of the box. This set the entire box alight, and the heat kindled all the matches in the box. The heat generated decomposed the chlorate lozenges, and the oxygen set free intensified the combustion tenfold. The result was the gentleman was instantly in flames, the combustion being of explosive violence. Had not a pail of water been thrown over him instantly the result must have been fatal, as the combustion was inconceivably violent.

Amaurosis, which it is said is produced by smoking, is defined to be "a loss or decay of sight from loss of power in the optic nerve, without any perceptible external change in the eye."

A much worse—and it is believed a common effort is what may be called mental and moral amaurosis or the weakening of what may be called the nerves of the mind, will and moral perception. A common symptom of this condition is the lack of perception by smokers, as our correspondent says, "that they are making nuisances of themselves." When a smoker with much indifference puffs his vile vapors, as they often do, into the faces of persons to whom it is disagreeable, it can only be attributed to two causes—either to mental dullness, that is inability to know that it is disagreeable, or to moral strabismus or lack of consideration for the comfort of those about them.

This leads up to what is the real purpose of this article which is smoking at technical meetings—such as those of Railroad Clubs, the Conventions of the Mechanical Engineers, Master Mechanics and Master Car Builders. At the January meeting of the New England Railroad Club this subject was brought up by Mr. Chamberlain who said that complaint is made that smoking during the sessions of the club is very embarrassing to those who do not use the weed—that is to some. It clouds the room, which finally causes the window to be opened to let the smoke out, the result being that there is great liability to catch cold, and in deference to these members who do not smoke, it has been suggested that a motion be made prohibiting smoking, in order to get the sense of the club with reference thereto. On motion of Mr. Adams, it was decided that from this time forth there should be no more smoking, which was unanimously carried. Not only is smoking very disagreeable to many people, but, as is claimed by those who practice it, it is a sedative and produces a state of languor or repose. That is instead of stimulating thought and mental activity, it has the reverse effect. Now the purpose of meetings, such as has been referred to, should be to stimulate thought, and thus excite discussion and not repress it. Any careful observer can see at such meetings that just as soon as cigars are distributed, and the audience is converted into a fumous body, that interest in the subject before the meeting is lessened, discussion lags and attention is diverted. When a man converts his mouth to the uses of a smoke-stack he consciously or unconsciously loses much of the gift of discussion. It is not quite certain what substances can and what cannot be penetrated by the Röntgen X rays that we have heard so much about lately, but it may safely be assumed that it is difficult for any one either to absorb or convey any very profound thought, which must penetrate through clouds of tobacco-smoke, in passing from the speaker to the hearer. Smoking detracts much from the dignity of such meetings, it lessens the interest in the subjects under consideration, it blunts the perceptions of the audience, and defeats what ought to be the main object in coming together. It is, therefore, moved, in the words of Mr. Adams, that "from this time forth we have no more smoking at these meetings."

Personal.

Mr. Henry McHarg has been elected President of the Texas Central.

Mr. M. C. Grace has resigned the position of Master Mechanic of the Monterey Mineral & Terminal Railway.

Mr. P. Maher has been appointed Master Mechanic of the Indiana, Illinois & Iowa Railway, vice Mr. L. H. Miller, resigned.

Mr. John Purcell has been made Assistant Master Mechanic of the Atchison, Topeka & Santa Fe at Argentine, Kan., in place of Mr. J. Forster, promoted.

Mr. John K. Cowen, President, and Mr. Oscar G. Murray, First Vice-President of the Baltimore & Ohio, were on Feb. 29 appointed receivers of that road.

Mr. H. G. Bowles, General Manager of the Monongahela River Railroad, has been appointed General Superintendent, and Mr. J. A. Feckinger succeeds him as General Manager.

Mr. W. A. Mills, Assistant to the late President of the Columbus, Hocking Valley and Toledo road, has been appointed General Manager of that road, with headquarters at Toledo.

Mr. Merle Middleton has resigned the position of Western Manager of the Safety Car Heating & Lighting Company to become associated with the Standard Steel Works of Philadelphia.

Mr. Hiram S. Cable, son of Mr. R. R. Cable, President of the Chicago, Rock Island & Pacific, has been appointed to the position of Vice-President and General Manager of the Rock Island & Peoria.

Mr. E. L. Chapman has been appointed Assistant Superintendent of Motive Power of the Southern Railway, to succeed Mr. Thomas, who, as noted last month, was promoted to the head of the department.

Mr. C. B. Hart, for several years a Traveling Freight Agent for Chicago, Rock Island & Pacific, has resigned, and will become General Manager of the Hutchison & Southern, a line of 80 miles in Southern Kansas.

Mr. Wm. Taussig has resigned the presidency of the St. Louis Terminal Association because of ill health, and is succeeded by Mr. J. S. Walsh, formerly Vice-President. Mr. E. P. Bryan, General Manager becomes Vice-President.

Mr. Theodore Klein, now General Superintendent of the Central of Georgia, will on May 1st, take the position of General Manager of the Inter-Oceanic Railway, of Mexico. Mr. Klein was formerly on the Mexican National Railway.

Mr. T. E. Adams, Master Mechanic of the Northern Division of the Great Northern Railway Line, has been appointed Superintendent of the Dakota Division of that road, and Mr. T. E. Cramer has been appointed Master Mechanic in his place.

Mr. T. W. Demorest has been transferred from the position of Assistant Engineer in the Motive Power Department of the Pennsylvania lines at Columbus, O., to be Assistant Master Mechanic at the Indianapolis shops of the company.

Mr. William J. Morden, recently the head of the Morden Frog & Crossing Works, died at his home in Chicago last month. The plant of the company in which he was so prominent was started about 1880 at Chicago. The present large plant at South Chicago was erected in 1884.

Mr. Joseph B. Stewart has been appointed to succeed Mr. Wm. G. Watson, deceased, as Superintendent of the Hudson River division of the West Shore Railway, and Superintendent of the Wallkill Valley and Jersey Junction roads. Mr. Stewart was formerly Superintendent of Telegraph and Signals.

Mr. E. Dawson has been appointed General Master Mechanic of the Kansas City, Pittsburgh & Gulf Railway, with headquarters at Pittsburgh, Kan. Mr. Dawson was formerly Superintendent of Machinery of the Des Moines & Kansas City Railway, which position he resigned to accept the appointment mentioned.

The death of Mr. N. J. Paradise has resulted in several changes in the mechanical department of the Burlington system. Mr. F. A. Chase has been made Master Mechanic of all the Missouri lines, with headquarters at St. Joseph, Mo., and Mr. I. N. Wilbur has been appointed Division Master Mechanic at Hannibal, to succeed Mr. Paradise.

Mr. Charles G. Waldo, General Superintendent of the Cincinnati, Hamilton & Dayton, succeeds Mr. Wm. M. Greene as General Manager of that road. Mr. Waldo was formerly on the Michigan Central and went to the Cincinnati, Hamilton & Dayton in 1889 as Purchasing Agent. He was then promoted to Assistant to the President, General Superintendent, and now is made Manager of the road.

Mr. Robert B. Campbell, General Manager of the Baltimore & Ohio Railroad, has resigned and has been succeeded by Mr. William M. Greene. Mr. Campbell went to the Baltimore & Ohio in 1892, and became General Superintendent of the Trans-Ohio Division. He became General Manager in 1893. His successor, Mr. Greene, was formerly General Manager of the Cincinnati, Hamilton & Dayton Railway.

Mr. George B. Hazlehurst has resigned the position of General Superintendent of Motive Power of the Baltimore & Ohio Railroad, which he has held since 1891. He entered the Baltimore & Ohio service when a boy, serving first as a clerk, and afterward with surveying parties, until he became assistant surveyor. He was later transferred to the bridge department, where he remained until made superintendent of motive power.

Mr. W. H. Canniff has been appointed General Manager of the Lake Shore & Michigan Southern, and Mr. P. S. Blodgett, General Superintendent. Mr. Canniff has been General Superintendent since 1890, and was previously Division Superintendent on the Lake Shore for many years. Mr. Blodgett had also been a Division Superintendent of the Lake Shore for years, until 1892, when he was made Assistant General Superintendent.

George H. Nettleton, President and General Manager of the Kansas City, Fort Scott & Memphis Railroad, died of paralysis in Kansas City, Mo., March 26. Mr. Nettleton was one of the best known railroad men in the West, and was 65 years old. He was born in Chicopee Falls, Mass., Nov. 13, 1831, and first entered the railroad service on March 7, 1851, as rodman on the New Haven & New London Railroad, of Connecticut, which afterward formed a part of the shore line of the New York, New Haven & Hartford Railroad.

Mr. Harvey Middleton, recently Superintendent of Construction at the Pullman works of the Pullman Palace Car Company, has been appointed General Superintendent of Motive Power of the Baltimore & Ohio Railroad. Mr. Middleton was appointed superintendent of machinery on the Louisville & Nashville in 1884. Five years later he went to the Atchison, Topeka & Santa Fe, and shortly afterward became superintendent of motive power and machinery of the Union Pacific, which position he held until he went with the Pullman Company.

James H. Stewart, formerly General Manager of the Cincinnati, Washington & Baltimore, was found dead in his room at Sandusky, March 15, having been suffocated by natural gas escaping from a stove. Mr. Stewart was born at Rochester, N. Y., May 8, 1827, and began railway work in 1848, on the Rochester & Niagara Falls road. From 1853 to 1858 he was superintendent of construction on the Wabash, and for the next nine years was General Superintendent of the Sandusky, Mansfield & Newark. From 1867 until 1874 he was General Superintendent of the Winona & St. Peter. He was General Manager of the Cincinnati, Lafayette & Chicago from 1875 to July, 1879, and was General Manager of the Marietta & Cincinnati from 1879 to 1881. In 1883 he was made General Manager of the Cincinnati, Washington & Baltimore, which position he held until Jan. 1, 1890. He was active in the construction of the Sandusky & Hocking, and was a director of that company.

William A. Parry, son of Charles T. Parry, late of the Baldwin Locomotive Works, of Philadelphia, died in British India on February 8. Mr. Parry was left a large estate. He was 35 years old, and started in October last for a tour of the world. He had reached the base of Mount Everest, near Calcutta, when he died. His friends in this country have not yet learned the cause of his death. Mr. Parry was owner of the schooner yacht *Telfer*. He was a member of the New York Yacht Club and one of the founders of the Corinthian Yacht Club of Philadelphia, of which he was for a time vice-commodore. He was also a member of the Bachelors' Barge Club, Union League and Art Club in Philadelphia, and a member of the Colonial Club, of New York. He leaves a wife and one child. The body is on its way home, and will be buried in Philadelphia.

William G. Watson.

Mr. William G. Watson, Superintendent of the Hudson River Division of the West Shore Railroad, died on March 10 from the effects of wounds received March 5, at the hands of a discharged employee. Edmund Clifford, who had been employed by the road as a detective, was discharged for drunkenness, and went to Mr. Watson's office, while under the influence of liquor, to complain of his discharge. After a brief parley he drew a pistol and fired at Mr. Watson several times, the second shot wounding him fatally.

Mr. Watson was the son of a clergyman, and was born in Prince George County, Maryland, in 1854. He entered railroad service as a telegraph operator, and served as operator, station agent, dispatcher, etc., on the Queen Anne & Kent County, Huntington & Broad Top and Allegheny Valley Railroads. He entered the service of the West Shore in 1883, and for several years was car accountant. He became superintendent in 1890. He took an

active interest in the work of the Car Accountants' Association, American Railway Association, American Society of Railroad Superintendents, the New York Railroad Club and other societies. He occupied the office of secretary of the latter society at the time of his death. He was an energetic worker, and widely known and respected in railroad circles. He leaves a wife and three daughters.

Nathaniel W. Pratt.

Through the announcements in the daily papers most of our readers will have learned before this notice reaches them of the death of Nathaniel W. Pratt, President of the Babcock & Wilcox Company, which occurred on March 10, at his home, in Brooklyn, N. Y.

He was descended from old New England ancestry, who on both his father's and mother's side settled in Plymouth County, Mass., in 1630, although he was born in Baltimore in 1852, and was therefore, 44 years of age at the time of his death.

He inherited from his father—who during the war was superintendent of the Burnside armories in Providence, R. I.—an aptitude for mechanics, and in 1870 he entered the employ of the firm of Babcock & Wilcox, who were then manufacturing boilers and engines. Through his energy and remarkable business qualifications he soon gained the confidence of his employers. In 1881 the firm was organized into a corporation, and he was then appointed Treasurer and Manager of it. He filled these positions until 1893, when, on the death of Mr. Geo. H. Babcock, one of the founders of the original firm, he was elected President of the company which position he held until the time of his death.

He had the rare characteristic of combining engineering and inventive ability with remarkable capacity for conducting business affairs, and it was to his exertions largely that the remarkable success of this company was due. In 1884 he became consulting engineer to the Dynamite Gun Company, and it was from his designs and under his patents that the first successful dynamite gun, which was of 8-inch caliber and 60 feet long, was built, and it was with it that the experiments at Fort Lafayette, in New York harbor, were made in throwing torpedoes.

He was for 25 years associated with the Babcock & Wilcox Company and firm, and the growth of that establishment and the success of its business was largely due to his business sagacity and sound judgment, and it now occupies the position of being one of the largest boiler manufacturing companies in the world, and it is to it that the success of water tube boilers is largely due. Mr. Pratt was energetic and aggressive in the conduct of business affairs, but also had the reputation of being generous and of a kindly disposition towards those less favored by fortune than he was.

He was a member of the American Society of Mechanical Engineers, the American Institute of Mining Engineers, American Naval Institute, and of the Engineers' Club of New York. His aged father and mother, his wife and three children survive him.

Notes.

An accurate measurement of coal consumption and horse power of a 22 and 40 by 48-inch, Reynolds-Corliss condensing engine for three years shows that in 1893 an average of 381 horse power was obtained on 1.76 pounds of coal per horse power per hour, in 1894 an average of 393 horse power at 1.67, and in 1895 an average of 396 at 1.65 pounds. The engine and boilers, which were also of the Reynolds type, were at the Stevens Linen Works at Webster, Mass. The owners of the plant obtained the figures, and they state that they indicated the engine morning and afternoon and carefully weighed all coal.

A section of a combined parlor and sleeping car from the designs of L. F. Ruth has been recently constructed at the shops of the Pittsburgh and Lake Erie Railroad. Pneumatic cushions are used for berths and chairs and the berths are stored in casings on the sides of the car which do not interfere with light or ventilation. The collapsed mattresses occupy but little space and when the berths are made up the parlor chairs are stored between the floor and the lower mattress, being removed from their base which are large enough to contain the bedding.

Four pumping engines each of 30,000,000 gallons daily capacity have recently been built by the Southwark Foundry & Machine Company for the city of Philadelphia. The engines are of the vertical, triple-expansion type and have cylinders 37, 62, and 96 inches in diameter, and three single acting pump plungers 34½ inches in diameter, all of 54-inch stroke. The total weight of each engine proper is about 1,000,000 pounds, or 2,000 tons, for the four engines, and the pumps and their attachments add 2,500 tons to this amount. A noteworthy feature of this pumping plant is the substitution of steel structural work in place of the usual cumbersome and expensive masonry work for the support of the engines. This construction gives easy access to all parts of the water end for examination, and in case of necessity the pump chambers can be removed and replaced with but little work. The Southwark Foundry has been the first to use this method of construction for supporting engines and had found it to be perfectly rigid. The engines described have run noiselessly and with little vibra-

tion, and there is every reason to suppose that the supports will be as rigid as a masonry foundation. The plant was fully described in a paper by Mr. T. H. Mirkil, Jr., before the Engineers' Club of Philadelphia.

From a circular recently issued by the Forestry Division of the Department of Agriculture it appears that careful estimates place the forest area of the United States (exclusive of Alaska) at about 500,000,000 acres, and that there are standing ready for the ax a total of 2,300,000,000,000 feet, board measure, of lumber of all kinds. The annual cut is 40,000,000,000 feet. Adding the consumption for fuel, fence material, waste in the woods and at the mills brings the total annual wood consumption of the country up to 25,000,000,000 cubic feet, or about 50 cubic feet per acre of forest; which is equivalent to the yield per acre realized in the well-kept forests of Prussia, where reproduction is secured by skillful management.

Mr. F. H. Stark, master car builder of the Cleveland Lorain & Wheeling, informs us that he has substituted metal head lining in place of cloth in some of the road's old passenger cars. Suitable designs can be found such as are used for small rooms, with raised work not too bold and quite appropriate for coach headlining. As a rule, stamping works make the sections in squares 2 ft. by 2 ft., but he got the last lot in sections 2 ft. by 8 ft. They are secured to the ceiling with lap joints without battons. He thinks there is a possibility of some trouble with joints opening after a while so as to be noticeable. He paints the lining a drab color that will not show the effect of smoke and yet make the car light. This is quite a departure in the way of color, but it has a good effect. The cost is so reasonable and the work so permanent that it is worthy of consideration on the part of those seeking economy.

The North of England correspondent of *The Engineer* writes to that paper:

"A new departure in marine engineering has been made at West Hartlepool, where the *Inchmuna*, a new screw steamer, is to be fitted with the first set of Mudd's patent five-cylinder and four-crank engines, with boilers working at a pressure of 255 pounds per square inch under induced draught. Mr. Thomas Mudd, the inventor, is the Mayor of Hartlepool, and is the managing director of the Central Marine Engine Works, which will supply the engines. The object of the invention is to obtain a greater economy of fuel than has been possible with the triple-expansion engine. It is little more than thirty years since the introduction of the compound engine with a boiler pressure of 65 pounds."

The *Engineer* is authority for the statement that the cogwheel and rack railways of the world include 70 lines built since 1812; and of these 17 are in Switzerland, 14 in Germany, 12 in Austria-Hungary, 4 in France and 3 in Italy, the others being in England, Spain, Greece, Portugal, the United States, South America, Asia and Australia. The total length of these lines is 500 miles, of which 188 are of the Abt system. These lines are worked by 300 locomotives, the heaviest of which weighs 70 tons.

The committee on the supervision of the standards and recommended practice of the Master Car Builders' Association will be glad to receive suggestions in reference to any such modifications of the established standards and recommended practices of the association as are justified by experience in their use. Members believing changes or additions should be made to any of these standards should communicate with Mr. R. H. Soule, chairman, Roanoke, Va.

The committee of the Master Mechanics' Association that is to report on "What kind of grate is most suitable for burning anthracite coal—cast-iron shaking or water bar?" has issued a circular of inquiry containing 35 questions. We have not the space to publish this important circular, but the members having information on this subject can render good service to the committee and the association by sending answers to the questions to Mr. Ed. L. Coster, 10 Wall street, New York City.

The latest schedule of the Philadelphia & Reading railroad shows that a new train has been put on that makes the trip from Philadelphia to New York in 1 hour and 45 minutes, or 15 minutes shorter than the fastest previous schedule. The train has three vestibuled cars weighing about 100 tons, and is hauled by a Vaclain compound locomotive with a single pair of drivers 84½ inches in diameter. The engine has a leading four-wheeled truck with 36-inch wheels, and a pair of trailing wheels under the firebox that are 54½ inches in diameter. The cylinders are 13 and 22 inches in diameter and 26 inches stroke. The boiler has 1,460 square feet of heating surface and carries a pressure of 200 pounds. The weight on the drivers is 48,000 pounds and the total weight of the engine is 110,500 pounds. The train leaves Philadelphia at 8:20 a. m. and arrives at Jersey City, 90.2 miles, at 9:53, making two stops, and averaging 58.2 miles per hour. The time for one stretch of 7½ miles is 70 minutes, or 64.7 miles per hour. West-bound the time is five minutes slower.

It has been found by several of the prominent roads entering Chicago that the boring of locomotive tires need not be the expensive and lengthy job it is usually found to be. By increasing the feed and, if necessary, using water on the tools to keep them cool, the work can be greatly ac-

celerated. A 50-inch tire can be bored in less than an hour and where one man has more than one machine to operate the cost of boring a tire of this size need not cost the company more than 25 cents. The larger tires cost proportionately more.

The trustees of the New York and Brooklyn Bridge, at a meeting held March 23, adopted the report of Superintendent Martin recommending that electric motors be used for switching trains at the terminals. It is expected that twenty cars will be equipped with motors, each car being provided with four of 62½ horse-power each. This will give a maximum drawbar pull of 6,600 pounds. These motors are expected to haul trains over the bridge in the early morning hours, or at other times should the cable fail. The Superintendent was instructed to prepare plans and specifications for the installation, and to advertise for bids for electric heaters for these cars. The cost of the power house and the machinery is estimated at \$300,000. The Executive Committee of the trustees recommends that the contract for the motors be awarded to the General Electric Company on its bid of \$3,645 a car.

Economical Designing of Timber Trestle Bridges.

Bulletin No. 12 of the timber physics series being issued by the United States Department of Agriculture contains an article under the above caption from the pen of A. L. Johnson, C. E., with several letters of comment upon it from prominent engineers. The article begins by showing that there are 2,000 miles of timber trestle in this country costing more than \$60,000,000 and requiring replacement, on an average, every nine years. The need of economy in the design is thus apparent. Data from the present practice of railroads shows that there is no uniformity in design, the factor of safety in beams running from 1.5 to 13, and the factor for endwise crushing ranging from 2.6 to 25. Other irregularities in present practice are shown, and then under the head of "Recommended Practice" the author says:

Since the strength of timber varies very greatly with the moisture contents (see Bulletin 8 of the Forestry Division), the economical designing of such structures will necessitate their being separated into groups according to the maximum moisture contents in use.

MOISTURE CLASSIFICATION.*

CLASS A (moisture contents, 18 per cent.).—Structures freely exposed to the weather, such as railway trestles, uncovered bridges, etc.

CLASS B (moisture contents, 15 per cent.).—Structures under roof but without side shelter, freely exposed to outside air, but protected from rain, such as roof trusses of open shops and sheds, covered bridges over streams, etc.

CLASS C (moisture contents, 12 per cent.).—Structures in buildings unheated, but more or less protected from outside air, such as roof trusses or barns, inclosed shops and sheds, etc.

CLASS D (moisture contents, 10 per cent.).—Structures in buildings at all times protected from the outside air, heated in the winter, such as roof trusses in houses, halls, churches, etc.

The following tables of safe loads have all been made out for Class A, with the intention of making them applicable to bridge-trestle construction. To make these applicable to the other classes make the following modifications:

For longleaf pine add to all the values given in the tables, except those for modulus of elasticity, tension and shearing, for Class B, 15 per cent.; for Class C, 40 per cent., and for Class D, 55 per cent. For the other species add to these values, for Class B, 8 per cent.; for Class C, 18 per cent., and for Class D, 25 per cent.

For the modulus of elasticity add only one-half of the above percentages. For tension and shearing use the tabular values—whatever the percentage of moisture.

For longleaf and shortleaf pine these modifications are quite correct, the percentage of increase of strength of the former being about twice as great as that for the latter between the green and dry conditions. This percentage of increase is not so well known for the other species, but tests that have been made indicate a percentage of increase at least as large as for shortleaf pine. Until further tests have been made, therefore, the modifications given above may safely be used.

*The reductions for moisture as given above in the case of longleaf pine appear somewhat at variance with results obtained since. In the case of other species they rest on assumption, for which experimental data are still largely lacking; it will, therefore, be proper to use the same with caution.

The moisture condition at 18 per cent. is one difficult to obtain under natural conditions; it would, therefore, have been more desirable if the author had started from the green condition, which is fixed. The following values for green condition are here added for the four Southern pines, on which alone the Forestry Division has reliable data:

	Moist- condi- tion.	Cuban pine.	Long- leaf.	Loblolly.	Short- leaf.	Average change.
Transverse strength or modulus of rupture, green.....	33	6,150	6,200	5,830	5,230	.....
Compression endwise, green.....	33	4,150	3,660	3,430	3,460	.....
Relative strength as a mean of transverse and compression:						
Green.....	33	100	100	100	100	100
Half dry.....	20	125	119	122	120	122
Yard dry.....	15	149	143	147	138	146
Room dry.....	10	132	194	187	155	182

B. E. FERNOW.

SAFE UNIT STRESSES.

TABLE IV.—Safe unit stresses at 18 per cent. moisture.

[The values marked "D" were obtained from experiments made by the Forestry Division. The other values were obtained from various sources, chiefly the Tenth Census report, but so modified, as to give results comparable with Forestry Division values. To arrive at true average values of strength, multiply safe loads by factor of safety given in each column. The values for resilience and tensile strength are the ultimate values. The former is practically never used in designing. The latter is a factor impossible to develop in practice, since the piece will always fail in some other way, usually by shearing. (See descriptive text.)]

Species.	Modulus of strength at rupture per square inch.	Modulus of elasticity per square inch.	Elastic resilience per cubic inch.	Crushing strength endwise per square inch.	Crushing strength across the grain per square inch.	Tensile strength per square inch.	Shearing strength per square inch.
	Pounds.	Pounds.	Pounds.	Pounds.	Pounds.	Pounds.	Pounds.
Longleaf pine (<i>Pinus palustris</i>), D.....	1,550	720,000	1.30	1,000	215	12,000	125
Shortleaf pine (<i>Pinus echinata</i>), D.....	1,300	690,000	1.30	840	215	9,900	100
White pine (<i>Pinus strobus</i>), D.....	880	435,000	1.00	700	147	7,100	80
Norway pine (<i>Pinus resinosa</i>), D.....	1,090	568,000	.....	700	143	.....	.....
Colorado pine (<i>Pinus ponderosa</i>), D.....	980	414,000	.....	630	180	.....	.....
Douglas fir (<i>Pseudotsuga douglasii</i>), D.....	1,320	690,000	.....	880	167	.....	.....
Redwood (<i>Sequoia sempervirens</i>), D.....	1,410	725,000	.....	650	115	.....	.....
Red cedar (<i>Juniperus virginiana</i>), D.....	1,000	353,000	.....	700	250	.....	.....
Bald cypress (<i>Taxodium distichum</i>), D.....	1,000	450,000	1.10	675	130	.....	.....
White oak (<i>Quercus alba</i>), D.....	1,200	550,000	1.25	800	400	10,000	200
Factor of safety.....	5	2	1	5	3	1	4

Table IV. is a table of safe unit stresses of the various kinds for the materials employed in the construction of timber trestles. The "safe unit stress" is equal to the ultimate strength, as determined from the test, divided by a quantity which is called the factor of safety.

In designing add one half inch to each dimension obtained by use of above table to allow for weathering.

The values marked "D" in the table are considered quite reliable, especially those for longleaf and shortleaf pine. These are for a moisture of 18 per cent., representing a half dry condition, and were taken from a minimum moisture curve which represented the average strength of the lowest 10 per cent. of the non-defective pieces tested. This curve gives values from 15 to 20 per cent. less than the mean values obtained for the species, and material of this strength can readily be obtained even for full-sized beams and columns by an inspector of average intelligence.

The other values were obtained from various sources, chief of which was the Tenth Census report.

The information for these species is very meager, but the values given are considered safe, though probably not as economical as they might be if more extensive tests had been made.

As will be seen from an inspection of Table IV., the factor of safety is not a constant quantity, but ranges from 2 to 5. In general, any composite structure should be of equal strength in all of its parts. This does not mean that they should all have the same factor of safety.

The values given for the modulus of elasticity for all the species except redwood and cedar will give, for the average conditions, a deflection equal to about one two-hundredths of the span, which has been assumed as the maximum allowable. This is about equal to a factor of safety of 5 on the total deflection at rupture. The exceptions to this are the two species above mentioned, but these are not used for beams.

The crushing strength across the grain in Table IV. is based upon a crushing of 3 per cent. of the cross-sectional height of the piece. This point may be compared to the elastic limit in the cross-breaking tests. While absolute failure does not occur at this point, yet it is a point beyond which it is unsafe to go. The point of absolute failure in this test is, more or less, an imaginary point, and the above percentage of crushing has been selected as an arbitrary representative thereof. As failure does not occur here, however, a factor of safety of 3 is deemed necessary and sufficient for this kind of a load.

INSPECTION.

Scientific inspection of timber requires a knowledge of the elements affecting the strength thereof.

The following are the principal elements: Moisture condition; weight per cubic foot; size of piece; position in tree; defects, such as knots, cross-graining, ring shakes and season checks; anatomical structure; character of the secretions, such as resin, etc.; method of treatment previous to use.

Moisture condition.—This is the chief element affecting the strength of timber. The strength of a thoroughly seasoned piece is from 50 to 100 per cent. more than that of a green piece. To say that a certain piece of timber has a strength of a certain amount is of no service whatever in determining its relative strength unless the moisture condition is specified.

Weight.—In material of the same species, having practically the same anatomical structure and character of secretions, the strength varies directly as the weight for the same condition of moisture.

Size of piece.—This has some effect, but it is much less than has been generally supposed. The chief difficulty is in the seasoning of large pieces. If this is done carefully no allowance need be made in the safe loads given on account of size, except for more frequent defects.

Position in tree.—The strength varies with the position in tree. In old trees of pine, from 150 to 200 years of age, the strongest portion of the butt log will be at about one-half the radius from the center. As we go higher in the tree, the central part, though weaker than in the butt log, becomes the strongest portion of the cross-section.

Defects.—Large knots should not be allowed to come at the middle of a beam, either on top or bottom.

From the cross-breaking test are obtained the modulus of strength at rupture (R), the modulus of elasticity (E), and the elastic resilience per cubic inch (r). The modulus of strength at rupture is the intensity (in pounds per square inch) of the stress upon the extreme fibers of a beam at the point where, and at the time when rupture begins.

The modulus of elasticity is the ratio of Unit stress (in pounds per square inch)

Unit resistance (expressed as fractional part of length) The elastic resistance of a beam is the product of one-half the load into the deflection at the loaded point. For a beam loaded with numerous concentrated loads the resilience is one-half the total sum of each load into the deflection of beam at that point. This quantity is a function of the volume of the beam.

as they are a source of weakness in compression as well as in tension, though not quite to the same extent. The fibers around a knot run nearly at right angles to the axis of the tree, so that in a compression test these fibers are subject to a crushing strength across the grain, in which direction they are very weak.

Season cracks on top of a beam have little effect upon the strength, except as they may collect water and start rot. Those, however, on the side of a beam near the neutral plane, which for timber is usually a little below the middle, are very injurious, as they greatly increase the liability to shear along this plane.

Wooden beams, as ordinarily employed, are more apt to fail in this manner than in any other way. By putting a

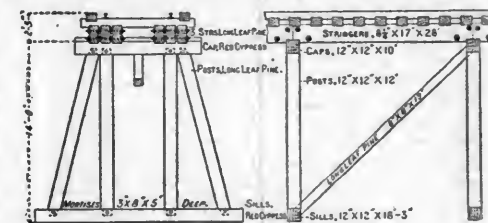


Fig. 1. Present Practice.

bolt in each end of large beams, thus firmly holding the top and bottom portions together, this danger could be largely avoided. Ring shakes are also prime causes of shearing along the neutral plane.

Anatomical Structure.—This has, of course, great influence upon the strength of timber, and to it is largely due the difference in strength between the different species.

But little is known about this subject as yet, except in a general way, as, for example, regarding pine and oak.

The present time is a little premature for the formulation of full rules for scientific inspection of timber. We only know that for strength we require dry timber, and for a given species the heavier the stronger.

For the present it is impossible to evaluate the effect of knots and other defects, but we should guard against them as far as possible.

The safe loads given in the tables herein will then be perfectly safe, and apply to all sizes.

METHODS OF DESIGNING.

PRESENT PRACTICE.

Many of the railroad companies now use a safe load of 1,000 pounds per square inch for the modulus of rupture for longleaf-pine stringers. The caps, sills, and posts are usually 12 by 12 inches, irrespective of load.

Fig. 1 represents a common type of construction designed by the above considerations and for the following con-

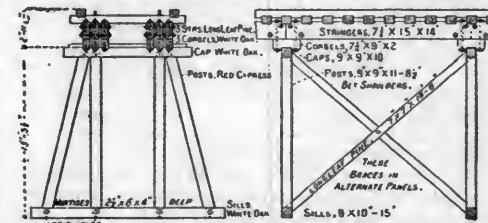


Fig. 2. Recommended Practice With Corbels.

ditions: Span 14 = 14 feet; length post = 12 feet; posts, caps, and sills, all 12 inches square. Load = 100-ton consolidation engine of the P. R. R. Maximum moment = 98,600 foot-pounds on one rail; maximum shear = 36,000 pounds on one rail; maximum bent load = 91,800 pounds on both rails.

The formula for bending is

$$M = R b h^2$$

M = bending moment in pounds per square inch.
R = safe load on extreme fiber in pounds per square inch
b = breadth of beam in inches.
h = height of beam in inches.

Substituting the values for these quantities, we find there will be required three stringers under each rail, 8½ by 17 inches in cross-section, posts, caps, and sills all being 12 by 12 inches in cross-section.

The following factors of safety are indicated by their practice:

Stringers in cross-breaking.....	7.6
Stringers in deflection at span.....	3.1
Stringers in bearing value.....	2.7
Cap, bearing value under stringers.....	1.5
Cap, bearing value under posts.....	1.9
Posts, crushing endwise.....	24.6

Bill of material for Fig. 2.
TIMBER, EXCLUSIVE OF TIES AND GUARD RAIL.

Species.	Used for—	Size.	Number feet B. M.	Cost per thousand.	Total cost.
Longleaf pine	Stringers.	6 Pieces, 7 1/2" x 15" x 14' in 14' lengths.	815	\$11.00	\$8.96
White oak	Caps.	1 Piece, 8" x 9" x 10'	66	11.00	.75
Red cypress	Posts.	1 Piece, 9" x 9" x 10'	351	8.00	2.81
White oak	Sills.	1 Piece, 9" x 10" x 15'	112	11.00	1.23
Longleaf pine	S. Braces.	1 Piece, 9" x 7" x 18' 6"	76	8.00	.61
White oak	Corbels.	6 Pieces, 7 1/2" x 9" x 2'	58	8.00	.46
Cost of iron.....			1,480		\$14.82
Total cost of panel.....					\$20.13

Bill of material for Fig. 3.
TIMBER, EXCLUSIVE OF TIES AND GUARD RAIL.

Species.	Used for—	Size.	Number feet, B. M.	Cost per thousand.	Total cost.
Longleaf pine	Stringers.	8 pieces, 7 1/2" x 14.5' 14' long.	982	\$10.50	\$10.31
White oak	Caps.	1 piece, 12" x 12" x 10'	120	11.00	1.32
Red cypress	Posts.	4 pieces, 12" x 12" x 13'	331	8.00	2.64
White oak	Sills.	1 piece, 9" x 10" x 15'	112	11.00	1.23
Longleaf pine	S. braces.	1 piece, 7" x 7" x 18' 6"	76	8.00	.61
Cost of iron.....			1,641		\$16.28
Total cost of panel.....					\$19.45

Bill of Material.
TIMBER, EXCLUSIVE OF TIES AND GUARD RAIL.

Species.	Used for—	Size.	Number feet, B. M.	Cost per thousand.	Total cost.
Longleaf pine	Stringers.	6 pieces, 8 1/4" x 17" x 14' in 28' lengths.	982	\$13.00	\$12.80
Red cypress	Caps.	1 piece, 12" x 12" x 10'	120	11.00	1.32
Longleaf pine	Posts.	4 pieces, 12" x 12" x 13'	331	8.00	2.64
Red cypress	Sills.	1 piece, 12" x 13" x 16' 3"	195	11.00	2.14
Longleaf pine	S. braces.	1 piece, 8" x 8" x 19'	101	8.00	.81
Cost of iron.....			2,046		\$22.25
Total cost of panel.....					\$25.11

Figs. 2 and 3 show designs recommended by the Forestry Division, that in Fig. 2 being preferred, though slightly more expensive than that in Fig. 3. These diagrams illustrate an

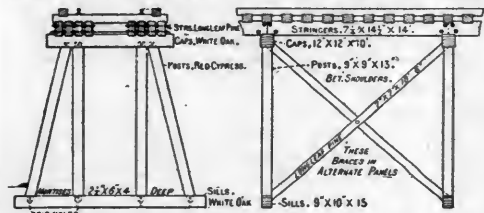


Fig. 3. Recommended Practice Without Corbels.

important point, i. e., that the economical design of timber structures require the judicious employment of different species as well as different sizes in the same.

Recommended practice with corbels:

Factors of Safety.

Stringers in cross-breaking.....	5
Stringers in deflection, 1/2 span.....	3
Stringers in end bearing.....	4
Cap in bearing valve.....	3
Posts in endwise crushing.....	7.4

Without corbels:

Factors of safety.

Stringers in cross-breaking.....	5
Stringers in deflection, 1/2 span.....	3
Stringers in end bearing.....	4
Cap in bearing valve.....	3
Posts in endwise crushing.....	7.4

The designs in Figs. 2 and 3, though capable of carrying twice as much load as that shown in Fig. 1, show a saving of \$5 per span, equal to 36 cents per linear foot of track and 28 per cent. less timber.

Assuming that this would be representative of one-half the total mileage of timber trestle bridges, i. e., 1,000 miles, we have a total saving every nine years of \$1,000,000, which is equal to an annual expenditure of \$211,000. This capitalized at 4 per cent. gives a capital of \$5,275,000. These 1,000 miles of trestle use annually about 120,000,000 feet, B. M., of valuable timber, 35,000,000 feet of which might readily be saved.

The tables of cost accompanying these designs upon which the above figures have been based are, of course, subject to great modification, depending upon the location, condition of the market, etc. It is thought, however, that they give a fair representation of the average conditions.

Advantages of Raising the Boiler and the Center of Gravity of Engines with a View of Obtaining an Increase in Power and Decrease in the Strain on the Permanent Way.*

The considerations put forward in the following seem to show successfully that the limits at present assigned to the power of express engines rest on somewhat imaginary bases and may be considerably extended. This splendid piece of machinery which has up till now met all requirements has not yet reached its final development and seems capable of meeting still further calls upon it in the future without the necessity of our having recourse to any special device or to new arrangements.

* Translated from the *Genie Civil* of Nov. 23, 1895 and appearing in the English edition of *Bulletin of the International Railway Congress*, for Feb. 1896.

The tendency toward keeping the center of gravity low which for a long time was prevalent among engine manufacturers has undoubtedly helped to retard development. The barrel of the boiler, cramped between the driving wheels could not be made larger; the firebox had no longer sufficient depth in order to be prolonged backward, it had to be above a driving or coupled axle and this led to the following recognized disadvantages: imperfect combustion, excessive heating of the tube plates and leakage at the tubes. It was only since what may to-day be called a prejudice was renounced that we have been enabled, by making the boiler to a certain extent independent of the other parts, to place express engines in this respect on the same footing as engines with wheels of small diameter and so markedly to increase their power.

The example it must be acknowledged came from abroad. In England, they were already building what appeared to us very high engines when the Americans, who had till then remained faithful to the classical patterns, decided under the spur of necessity to raise the boilers of their engines right above the wheels and subsequently went much further in this direction than any European builder had dared to go. The highest of these engines ("hailed one of the fastest trains in the world day after day on lines with but slight super-elevation and demonstrated that the utmost limit of stability had not yet been reached. The raising of the center of gravity of engines far beyond what would have been admitted as advisable a few years before was henceforth an accomplished fact and shown to be sound practice; the engineer could henceforth, without fear of trenching on the unknown, have recourse to a method which, while it allowed of engine steam power being increased, also presented special advantages.

The same object had been attained on both sides of the Atlantic by very different means. In England by far the larger proportion of express engines had wheels of large diameter as much as 7.7 feet (2.35 meters) for engines with single driving wheels (†) and internal cylinders. It was accordingly necessary to raise the boiler so as to leave room for the crank axle throws and the connecting rods and at the same time make the motion more easily accessible. In the United States, on the other hand, the cylinders were external and the driving wheels of small diameter. But the great weight of the trains necessitated powerful boilers and accordingly the latter had to be raised sufficiently to allow of the firebox frame being above the frame plate and the barrel of the boiler being above the driving and coupled wheels.

In the Crampton engine the axis of the barrel was situated 5.25 feet (1.605 meters) above the top of the rails, in the Orleans Company's external cylinder express locomotives it was 6.43 feet (1.96 meters), while in the Northern Railway's Outrance type it was 6.92 feet (2.12 meters). Later on this height was increased on some of the French lines and in most express engines recently built the axis of the boiler is between 7.21 feet and 7.47 feet (2.20 and 2.28 meters). We hear, it is true, of engines being designed in which the height is to reach 8.03 feet (2.45 meters). All express engines constructed in England during the last 12 years have been made with the axis of their boilers 7.44 feet (2.27 meters) high as a minimum; if the engines have internal cylinders and single driving wheels, the height usually reaches from 7.61 to 7.87 feet (2.33 to 2.40 meters), and exceptionally even 7.9 feet (2.41 meters) as in the North Eastern express engines. In Belgium, they have reached 7.77 feet (2.37 meters) and in Austria 8.2 feet (2.50 meters) in some engines actually being built. In the United States, the axis of the boiler barrel is at a height of 8.2 feet (2.50 meters) in the engines lately built and very often is as much as 8.52 feet, 8.69 feet (2.60 and 2.65 meters) and even reaches 8.95 feet (2.73 meters).

Some years ago, the New York Central Company adopted a type of express engine the boiler of which is situated just 8.35 feet (2.70 meters) above the rails.

The height nowadays regarded as a minimum in the United States is actually greater than the maximum in Europe.

Fig. 1, which shows diagrammatically on the same scale an express engine of a recognized and serviceable French type and one belonging to an American Company, gives a better idea than mere feet and inches of how far the Americans

(*) We allude to the New York Central four coupled engines which haul the *Empire State Express* at an actual speed of 51 miles (82 kilometers) an hour.

(†) This refers to engines with internal cylinders; with external cylinders, the diameter reaches 8.2 feet (2.50 meters).

have gone beyond us in the power and height of their engines.

For comparison's sake, we have brought together in a single diagram Fig. 2 the front views of three classical types of engines: an old Crampton, an express Midland engine (England), and an engine belonging to the New York Central (United States). The English engine is no doubt, very high, but as the driving wheels are of great diameter (7.74 feet = 2.36 meters) the diameter of the barrel of the boiler is smaller than the distance between the tires. The New York Central engine is much higher, and the boiler reaches beyond the top of the driving wheels, the diameter of which is 7.08

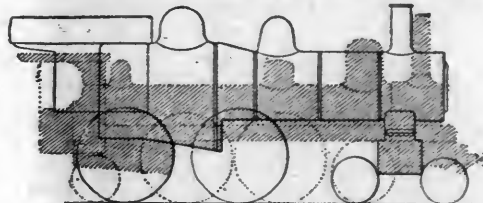


Fig. 1. Diagram of French and American Engines.

feet (2.16 meters). To allow of this engine running on our lines, we should have to cut off part of the chimney and the upper part of the dome. The top of the dome on the firebox is 12.3 feet (3.75 meters) above the rail.

Advantages from Raising the Center of Gravity.—In his work on the locomotive, published in 1877, Mr. Reynolds already stated that "of all express engines running at present the highest provide the greatest security." This assertion is doubtless not an axiom, but still it is in conformity with facts.

When the flanges of the wheels of a locomotive strike the rail on one side under the influence of centrifugal force at a curve, or of movements of oscillation, the engine gives the rail, everything else being equal, a jar which is all the more violent in proportion as its center of gravity is lower. If we suppose the center of gravity to be at the level of the rail, the strain due to the centrifugal force will be entirely transmitted to the rail; if the center of gravity were removed to an infinite distance above the permanent way, the engine would no longer have any stability, and under the influence of an infinitely slight centrifugal force would balance itself on the outer rail, without causing any appreciable strain tending towards displacement. In practice, every engine occupies an intermediate position between these two extreme conditions, but we can already draw the conclusion from the above that the higher an engine is the less will it tend to displace the permanent way. To make it absolutely safe, we

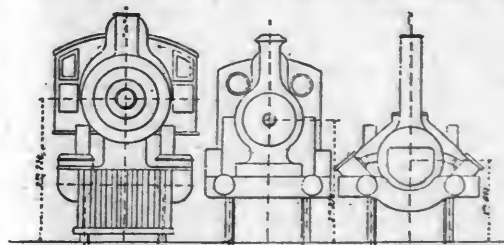


Fig. 2. Front Views of an Old Crampton, an English, and an American Engine.

shall only have to give it the minimum stability consistent with its running no risk of being upset when passing at full speed over curves of the smallest radius which will it have to pass. Now experience shows that this limit is not exceeded by the most lofty American engines.

In this way the more obliquely will it act upon the rail under the action of the transverse strains due to oscillation or centrifugal force. But—and this is the important point—as the engine is hung on springs, the higher its center of gravity the greater will be the proportion of its weight which will bear vertically on its outer wheels. This decreases the tendency toward derailment by loading the outer wheels more heavily and the tendency toward spreading of the gage by the extra weight on the outer rail. Moreover, as the springs come into play this action is felt gradually and without shock, while the strain due to centrifugal force when an engine possesses great stability acts suddenly and violently. The old Crampton engines displaced the permanent way, not so much on account of their long rigid wheel-base as because of their excessive stability.

The transverse movements of the engine on the road, due to oscillation or to centrifugal force, will react upon the flanges of the wheels, on the bearings, boxes and throws of the crank axle, and these reactions will be all the more severe and sudden in proportion as the center of gravity of the whole is lower. If the engine is very high it will roll more and its springs will come into play; at the same time it will not be so hard on the permanent way, and the wear and tear and the chance of the crank axles or boxes giving way will be appreciably less.

Advantages of Raising the Boiler.—In goods engines whose wheels are of small diameter, the barrel may be made of as large a diameter as required, with a view to obtain the necessary heating surface and volume of water; when the firebox is above the trailing axle, it still remains sufficiently low down to avoid the necessity of raising the whole boiler. Such is not the case with express engines, whose wheels are of larger diameter. If the barrel is not sufficiently raised, its diameter is limited to the distance between the tires of the wheels; moreover, if the trailing axle is coupled and goes beneath the firebox, the latter must be much flattened. For instance, with driving wheels 6.56 feet (2 meters) in diameter, if the axis of the boiler is 6.94 feet (2.10 meters) above the rails, the external diameter

of the barrel is limited to 4.26 feet (1.30 meters) when only the necessary play is left between the wheel flange and the boiler. If the axis of the boiler is 8.2 feet (2.50 meters) high the external diameter of the barrel may be increased to 4.92 feet (1.50 meters); if it be increased to 8.52 feet (2.60 meters), the diameter may be increased to 5.41 feet (1.65 meters), which seems more than sufficient for the most powerful express train.

Fig. 3 shows the back view of an American engine with 7.08 feet (2.16 meters) wheels, in which the boiler is situated sufficiently high to enable its diameter to be greater than the gage of the line.

We have shown above that, at any rate within the limits

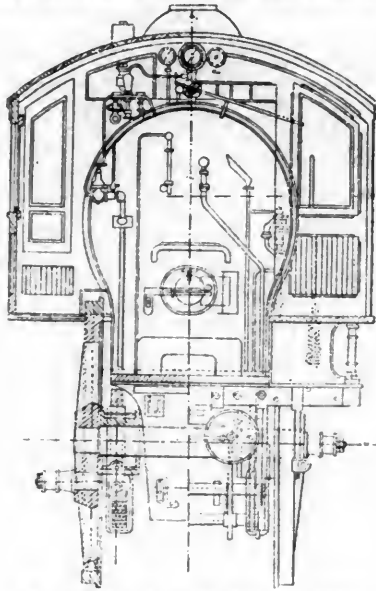


Fig. 3. Rear View of an American Engine.

actually attained, raising the center of gravity seems to offer nothing but advantage, and we have just seen that raising the boiler is necessary if we desire to increase the power of express engines. But we must now show that in raising the boiler the general center of gravity of the engine is raised to a much smaller degree. To imagine that the opposite might be the case implies that we are led away by the apparent volume of the boiler, which in bulk is much the largest part of what goes to make up an engine. Its average density is, however, very small. The weight of the boiler with its water does not, on the average, in a locomotive exceed a quarter of the total weight. Now the center of gravity of the other three-quarters is very low, consisting, as they do, of wheels, frame-plates, cylinders and other parts. Hence the center of gravity of the whole is much lower than one would be inclined to think at first sight, as the following instance will serve to show. Let us take a four-coupled bogie express engine, weighing 48 tons in working order, and having a boiler with a deep fire-box, the diameter of the barrel being 4.06 feet (1.24 meters), and that of the wheels 6.56 feet (2 meters). The center of gravity of the parts which carry the weight, make up the mechanism and weigh 36 tons would be about 3.21 feet (0.98 meter) above the rail; the center of gravity of the boiler full of water, weighing twelve tons, would be about .98 foot (0.30 meter) below the axis of the barrel. Accordingly, if the latter is situated 6.88 feet (2.10 meters) above the rails, the center of gravity of the whole will only be 3.74 feet (1.14 meters) above the upper surface of the rails. If the axis of the boiler be 8.2 feet (2.50 meters) above the rails, the center of gravity of the whole would be only 4.06 feet (1.24 meters) high. In other words, as might have been foreseen, in raising the boiler 1.31 foot (0.40 meters) we have only raised the center of gravity of the engine .32 foot (0.10 meter).

Thus in an engine which is higher than any running in Europe—the axis of the barrel being 8.2 feet (2.50 meters) above the rail—the center of gravity for the whole is only 4.06 feet (1.24 meters) high, which is much lower than the height of the center of gravity of loaded wagons or of the ordinary passenger carriages and all the more of saloon carriages with high and heavy bodies. There are running on main lines cars whose center of gravity is 4.92 feet (1.50 meters) or more above the rails; in order that the center of gravity of an engine corresponding fairly closely to the description given above, should be equally high, the axis of the barrel would have to be 10.62 feet (3.24 meters) above the upper level of the rails, which is much higher than anything yet reached in the latest American engines.

Conclusions.—From what has been said it seems that the following conclusions may without risk be drawn:

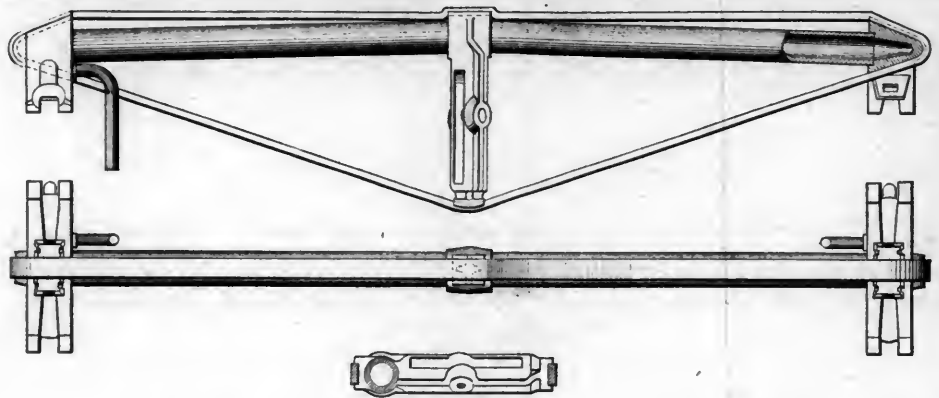
1. Within certain limits, which have so far not been reached in Europe, or even in America, raising the center of gravity of engines has nothing but good results. It results in decrease in the strain on the permanent way and on the parts which go to make up the engine, wheels, axles, boxes and frame plates. The running of the engines is made smoother because the springs come more into play under the action of lateral motion and in running round curves; the tendency to derailment is decreased by the increase of the load on the outer rail when curves are run over at a high rate of speed.

2. Raising the boiler seems to be the most practical, the most simple and the least costly method of increasing engine power, as it allows of the barrel having a diameter greater than the space between the ties.

3. As the boiler does not on the average make up more than about a quarter of the weight of an engine, if it be raised a given amount, the center of gravity of the whole is only raised about a quarter of that amount.

4. The center of gravity of the highest engines in use at present is much lower than that of passenger carriages and loaded wagons: it can therefore be considerably raised without fear of endangering safety.

What has been said above and the tendencies which from day to day become more marked, lead us to think that the future belongs to high engines, and that, cost what it may, we must endeavor to raise the boilers in order to make their power proportionate with the growing requirements of railway working, and with a view to decrease, in proportion as speed increases, the wear and tear on the permanent way.



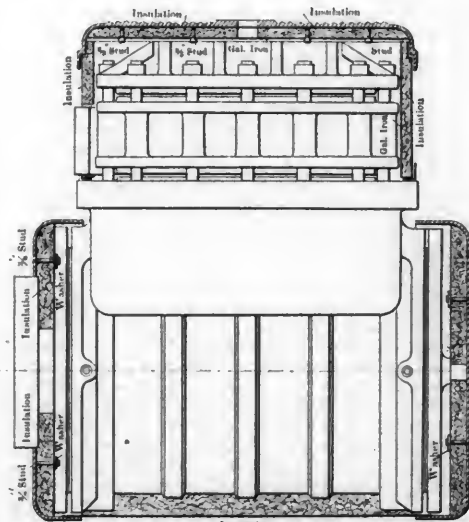
A New Brake-Beam.

A New Brake-Beam.

The accompanying illustration is a new brake-beam designed and patented by Mr. J. N. Barr, Superintendent of Motive Power of the Chicago, Milwaukee & St. Paul Railway. The compression member is of pipe and the tension member is a bar, rectangular in section, extending entirely around the compression member. The brake-heads are so made as to permit the tension member to be put on after it is formed into shape and welded. When heated and shrunk on it holds the heads firmly in place. The construction is exceedingly simple, and there is nothing about the beam to get out of order. It might possibly be argued that it could not be repaired on the road, but railroad men now appreciate the fact that metal beams should be repaired at the shops and not on the road. The beam is a few pounds heavier than some others because of the metal in the part of the truss back of the pipe, but that metal adds to the vertical stiffness of the beam, and is an advantage in that respect.

A Convenient Method of Jacketing Steam Chests and Cylinder Heads of Locomotives.

Many railroad men realize the advantage to be derived from thoroughly jacketing the steam chests and cylinder heads of locomotives, but this is seldom done because of the inconvenience the insulation causes when repairs are to be made, or the steam chest cover and cylinder heads removed for any reason. On the Chicago and Northwestern Railway engines are fitted with insulation in a manner which overcomes this objection, as will be evident from



Method of Jacketing Steam Chests and Cylinder Heads—Chicago & Northwestern Railway.

the accompanying illustration. The cylinder head casings have 1 1/2 inches of insulating material (which we understand is asbestos) held to the inside of each by a disk of galvanized iron secured by studs screwed into the casing. Evidently when the casing is removed, the insulation comes with it, and the workman would not know of its presence except for the increased weight of the casing.

The steam chest casing cover is provided with insulating material, secured in place in the same manner. The vertical sides of the casing are made double and the inner and outer sheets flanged toward each other, with the flange of the outer sheet under the other. The space between them is filled with asbestos and when the casing cover is on it is secure. The insulation on the back cylinder head is not so easily removed as that on the front one, but there is seldom occasion to disturb it. This matter of thoroughly jacketing all parts of a locomotive to which the heat of live steam is communicated is worthy of careful attention, for the saving to be effected at small outlay is considerable.

Trade Catalogues.

[In 1894 the Master Car-Builders' Association, for convenience in the filing and preservation of pamphlets, catalogues, specifications, etc., adopted a number of standard sizes. These are given here in order that the size of the publications of this kind, which are noticed under this head, may be compared with the standards, and it may be known whether they conform thereto.]

It seems very desirable that all trade catalogues published should conform to the standard sizes adopted by the Master Car Builders' Association, and therefore in no future catalogues hereafter it will be stated in brackets whether they are or are not of one of the standard sizes.]

STANDARDS.

For post-card circulars..... 3 1/4 inches by 6 1/4 inches.
Pamphlets and trade catalogues..... 3 1/4 inches by 6 inches.
Specifications and letter-paper..... 6 inches by 9 inches.
..... 9 inches by 12 inches.
..... 8 1/4 inches by 10 3/4 inches.

LEAD LINED IRON PIPE COMPANY. Manufacturers of Standard Lead Lined Iron Pipe and Fittings. Wakefield, Mass. Price list No. 16. 16 pages. 5 1/2 by 8 1/2. (Not standard size.)

This company manufactures wrought-iron pipes which are lined with lead, the latter intended to resist corrosion, and the outside iron casing giving the requisite strength to resist internal pressure. Lining a pipe with lead is not very difficult, but the company makes all the fittings, couplings, elbows, tees, etc., which are also lead lined, and in such a way that part of the thread for screwing the parts together is cut in the lead and part in the iron. Cuts are given showing sections of the pipes and fittings, with tables of their dimensions.

THE THOMPSON-RYAN DIRECT CURRENT MULTIPOLAR ELECTRIC GENERATOR. Built by J. H. McEwen Manufacturing Company. Havemeyer Building, New York. Works: Ridgeway, Pa. 32 pages, 5 1/2 by 8 1/2 inches. (Not standard size.)

The frontispiece of this pamphlet is a half-tone engraving made from a wash drawing of the works at Ridgeway, Pa. In the introduction it is said that the company has made arrangements with Prof. Harris J. Ryan, of Cornell University, and Milton E. Thompson, the inventors of the Thompson-Ryan dynamo, for its manufacture. This, it is said, "is replete with novelties," but "has long since passed the experimental stage, as is fully attested by a number of large sized machines now in constant operation under the most trying conditions." They then proceed to give a full description of these machines, and also add interior views of the works where they are made. Following, then, are half-tone illustrations showing generators driven by horizontal direct connected simple and compound and also vertical engines. The details of the generator are also fully explained and some of them illustrated with very excellent half-tone engravings. The full-page engravings all have ornamented borders, which, with the letter-press, are printed in brown ink, the engravings being black. The paper and typography are all of the best.

ILLUSTRATED CATALOGUE AND PRICE LIST OF THE BOSTON GEAR WORKS, 31 Hartford street, Boston, Mass. 40 pages, 5 1/2 by 8 inches. (Not standard size.)

In this little pamphlet the publishers describe various kinds of small gears suitable for clock-work and very light machinery, and which doubtless will be useful to many of our readers, who, like ourselves, have often not known where such gears could be obtained. The different sizes, styles, etc., are illustrated and described by cuts and tables. "Intermittent gears," universal joint couplings, brass ratchets and pawls, miter bevel, crown, internal, elliptical and spiral gears, escape wheels, clutches, keys, small pulleys and hangers, chains and chain wheels, cotton worms and worm-gears, are all manufactured by this company and are described in the pamphlet before us. The company also manufacture gears for heavy machinery, but these, it is said, will be described in another catalogue.

NO. 55, PRICE LIST, GALVANIZED STEEL WIRE NETTINGS, WIRE FENCING, WIRE WINDOW AND DOOR SCREENS, ETC. De Witt Wire Cloth Company, 17 Warren Street, New York. 28 pages. 3 1/2 by 6 inches. (Standard size.)

This company manufactures steel wire netting for various purposes, cable for lightning rods, and fencing wire and ribbon fencing, wire window and door screens, etc., all of which are illustrated and described in the little volume before us the only fault of which is that it is printed in blue ink.

MORRIS MACHINE WORKS. Builders of Centrifugal Pumping Machinery, Engines and Boilers, Baldwinsville, N. Y. 32 pages. 6 by 9 inches. (Standard size.)

In the introduction to this catalogue the publishers say that "centrifugal pumps are constantly finding new favor

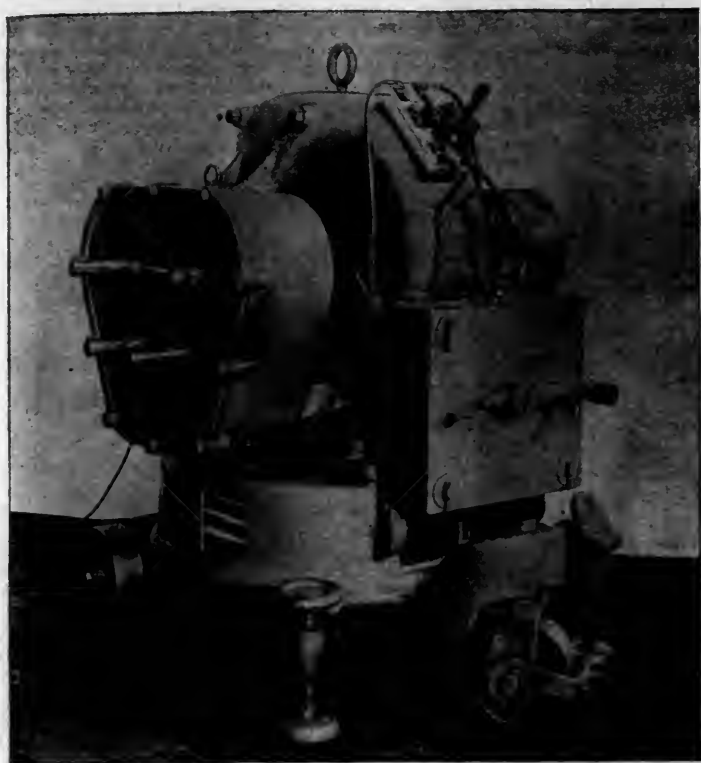


Fig. 1.

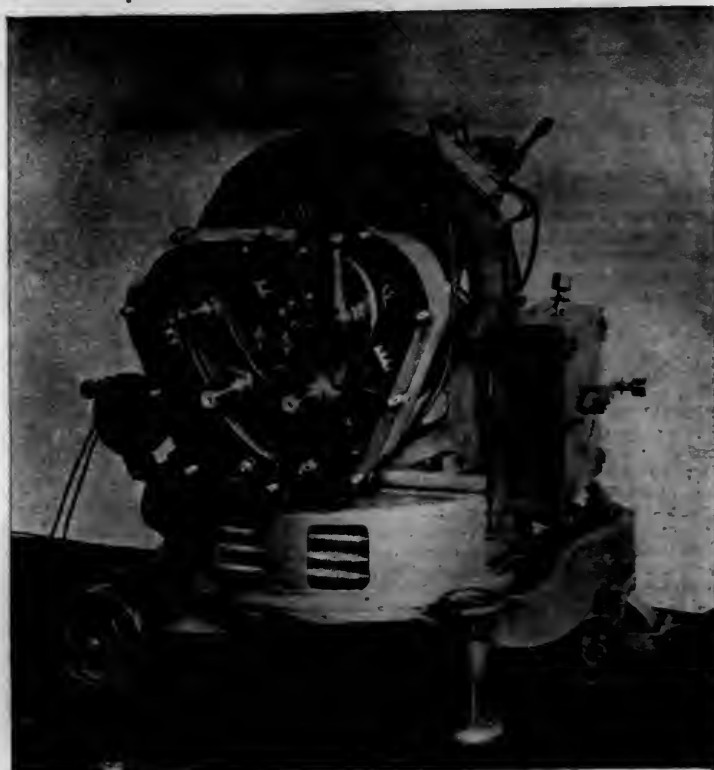


Fig. 2.

GIBBS' PORTABLE ELECTRIC MOTOR FOR SHOP USE.

from users, on account of their simplicity, durability, great capacity for handling material in large quantities, capability of pumping muddy and gritty water (which would shortly cut out any piston pump), their great economy of power under low lift and their low cost, which is anywhere from one-third to one-half that of any other type of pump."

In a following article the advantage of having a pump properly proportioned to the work which it must do is set forth and explained. Illustrations are then given of a large sewage pump with a direct connected engine, which is followed by an illustration and description of the different sizes of vertical pumps that is there, the shaft of which is in a vertical position. Several types of pumps, to be driven by belts, are then illustrated and described, and tables of drums of the different sizes are also given. This is followed by a curious diagram showing the position of the suction and discharge pipes of various patterns of pumps, 32 in all. It would hardly seem possible to place these pipes in so many different positions.

A number of illustrations follow, representing direct connected pumps, in which vertical engines are connected direct to the pump shaft. Several hydraulic dredging pumps to be driven by belts, and a portable pumping outfit and various details of these machines are shown.

The wood engravings are all excellent and the typography equally so, and the whole makes a very attractive volume.

The Gibbs Portable Electric Motor for Machine Shop and Round-House Work.

In shops where electricity is used for lighting and power purposes, portable electric motors can be used to advantage in the same lines of work that steam and compressed air motors are so frequently employed. In many situations they present superior advantages, because of the ease with which they can be connected to receive power, flexible wire cables taking the place of iron pipes for steam or air, and from the fact that there is no exhaust to be taken care of.

The Gibbs Electric Company, of Milwaukee, Wis., has recently designed and built a number of portable motors for general machine shop work, from photographs of which the accompanying illustrations were made. It is the intention to use these motors with Stow or other flexible shafts for such work as boring cylinders, facing valve seats, drilling staybolts, tapping sheets for staybolts, and general round-house and machine shop work, in which motors can take the place of man power with economy.

Figs. 1 and 2 are both rear views of the motor mounted on a three-wheeled track, Fig. 1 showing it complete, while in Fig. 2 the cover of the spindle case is removed. The commutator is on the further end of the armature shaft, and the pulley adjacent to it, which can be seen in Fig. 1, is used for belting direct to machine tools. Fig. 2, which is taken from a slightly different position, shows at the left a cable reel, on which is wound about 100 ft. of cable, allowing the motor to be moved within a radius of about 100 ft. from the supply of current. On the end of the cable is a plug, which can be inserted into sockets at

various points in the shop, so that the tools can be taken anywhere and receive power.

The motor is mounted on a round base, which in turn is mounted on the truck proper on a center pin. The round base is in the form of a turn-table, so that the motor can be swung around to suit the work. In this round base is placed the resistance coils, which vary the speed of the motor.

The box, or gear case, containing the drill spindles, is shown in both illustrations, Fig. 2 having the cover removed to show the gearing. The three spindles run at 177, 98 and 40 revolutions respectively. These speeds can, of course, be changed to suit any requirements which it may be necessary to meet. It may be noticed that there is a handle on the spindle box, similar to that used on the back gearing of lathes. When it is desired to use the pulley only, the gearing is by means of this handle thrown out of clutch, and the wear on the same is avoided.

On the right hand side, in both of our figures, is shown the main switch and controlling box with reversing switch. The reversing switch lever is seen projecting through the top of the box, and is interlocked with the controlling lever, so that it is impossible to reverse the motor unless it is first stopped. The resistance coils in the base will vary the speed of the motor from 900 to about 450 revolutions per minute, thus, of course, reducing the speed of the spindles proportionately.

When at work the motor is steadied by the two screws bearing on the floor, and the handle for hauling it about the shop can be taken off so as to be out of the way.

Everything about the motor is made on jigs and templates and is interchangeable. The gearing is the best obtainable. All the spindle bearings are exceedingly large, and, as the gears run in oil, perfect lubrication is obtained. The motor is five horse-power, and is sufficiently large to drive any ordinary machine tool found in railroad shop. The spindle running at 177 revolutions is intended for tapping in staybolts, and it has been found that it is possible to run staybolt taps at this speed. The other two speeds are for cylinder boring and valve-seat facing. If it is desired to use the spindles for running-rope drives, a pulley can be put on any one of them, the advantage of this being that the spindles are so reduced in speed that no countershaft is necessary.

The weight of this motor complete is 1,400 pounds, but, on account of its construction, is readily moved about the shop by one man. Everything about the motor, gearing and truck is of the best, and no expense has been spared in making the tool as perfect as possible.

The Becker Vertical-Spindle Milling Machine.

In the accompanying illustration we show an interesting vertical-spindle milling machine made by the John Becker Manufacturing Company, of Fitchburg, Mass. It is claimed for this machine, which is known as No. 5, that it is more practical, is of greater adaptability and has more labor-saving qualities than any horizontal spindle mill on the market. As a boring mill it is in many respects superior to the drill press.

The frame is heavy and very rigid, and is therefore suitable for heavy cuts. The spindle has long bearings running in bronze boxes that are adjustable for wear. The lower

end of it is threaded for chucks or large face mills. The shanks of end mills are secured by the drawbar which passes through the center of the spindle. To get rid of end play, the lower bearing is provided with ball thrust bearings at both ends, thus reducing friction and securing a level surface when using face mills. The driving pulley of the spindle is 15 inches diameter and 3 1/4 inches face, and double back-geared 5 to 1. It is independently mounted to secure the permanent alignment of the spindle. This is a valuable feature on a vertical spindle milling machine, as without it the spindle is eventually worn out of alignment, impairing the general usefulness of the machine, by making the use of large surface mills impracticable, for obvious reasons.

The head has a vertical traverse of seven inches automatically and with automatic release. It is provided with a stop gage graduated to thousandth of an inch.

The knee has a vertical adjustment of 18 inches, and the greatest possible distance between table and spindle is 21 inches. The table is 48 by 13 inches (working surface), and has an automatic feed of 40 inches. The saddle, which is the same length as the table, has a cross feed of 13 inches. The



The Becker Milling Machine:

rotary attachment, with an automatic feed in either direction, is found to be an exceedingly useful feature. The table is 22 inches in diameter and will swing work 34 inches.

The table has six changes of straight and rotary feed for each change in speed. An arbor support, attached to the knee, is provided for use with long arbors for slab or straddle milling. Gripping jaws, 9 inches by 2 inches, fitting the slots in the table, also accompany the machine.

The workmanship and materials are guaranteed to be of the best and no pains are spared to make it a reliable and accurate machine. A glance at the illustration shows it to be a handy and convenient tool for many kinds of work. In drilling and boring work it has a large range and the rotary feed makes it possible to mill out large holes with great accuracy. The machine complete with countershaft weighs about 4,300 pounds.

The success of this tool has been remarkable not only in this country but also abroad. A firm in Budapest, Hungary, are using two of them and has just ordered a third.

of the barrel is limited to 4.26 feet (1.30 meters) when only the necessary play is left between the wheel flange and the boiler. If the axis of the boiler is 8.2 feet (2.50 meters) high the external diameter of the barrel may be increased to 1.92 feet (1.50 meters); if it be increased to 8.52 feet (2.60 meters), the diameter may be increased to 5.11 feet (1.65 meters), which seems more than sufficient for the most powerful express train.

Fig. 3 shows the back view of an American engine with 7.08 feet (2.16 meters) wheels, in which the boiler is situated sufficiently high to enable its diameter to be greater than the gauge of the line.

We have shown above that, at any rate within the limits

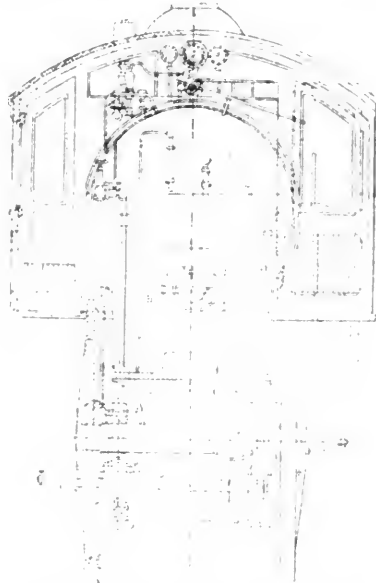


Fig. 3. Rear View of an American Engine.

actually attained, raising the center of gravity seems to offer nothing but advantage, and we have just seen that raising the boiler is necessary if we desire to increase the power of express engines. But we must now show that in raising the boiler the general center of gravity of the engine is raised to a much smaller degree. To imagine that the engine might be the case implies that we are led away by the apparent volume of the boiler, which in bulk is much the largest part of what goes to make up an engine. Its average density is, however, very small. The weight of the boiler with its water does not, on the average, in a locomotive exceed a quarter of the total weight. Now the center of gravity of the other three-quarters is very low, consisting, as they do, of wheels, frame-plates, cylinders and other parts. Hence the center of gravity of the whole is much lower than one would be inclined to think at first sight, and the following instance will serve to show. Let us take a four-coupled bogie express engine, weighing 18 tons in working order, and having a boiler with a deep fire-box, the diameter of the barrel being 1.06 feet (1.21 meters), and that of the wheels 6.56 feet (2 meters). The center of gravity of the parts which carry the weight, make up the mechanism and weigh 9 tons would be about 3.21 feet (0.98 meter) above the rail; the center of gravity of the boiler full of water, weighing twelve tons, would be about .98 foot (0.30 meter) below the axis of the barrel. Accordingly, if the latter is situated 6.88 feet (2.10 meters) above the rails, the center of gravity of the whole will only be 3.71 feet (1.11 meters) above the upper surface of the rails. If the axis of the boiler be 8.2 feet (2.50 meters) above the rails, the center of gravity of the whole would be only 1.06 feet (1.21 meters) high. In other words, as might have been foreseen, in raising the boiler 1.31 foot (0.40 meter) we have only raised the center of gravity of the engine .32 foot (0.10 meter).

Thus in an engine which is higher than any running in Europe—the axis of the barrel being 8.2 feet (2.50 meters) above the rail—the center of gravity for the whole is only 1.06 feet (1.21 meters) high, which is much lower than the height of the center of gravity of loaded wagons or of the ordinary passenger carriages and all the more of suburban carriages with high and heavy bodies. There are running on main lines cars whose center of gravity is 1.92 feet (1.50 meters) or more above the rails; in order that the center of gravity of an engine corresponding fairly closely to the description given above, should be equally high, the axis of the barrel would have to be 10.62 feet (3.23 meters) above the upper level of the rails, which is much higher than anything yet reached in the latest American engines.

Conclusions.—From what has been said it seems that the following conclusions may without risk be drawn:

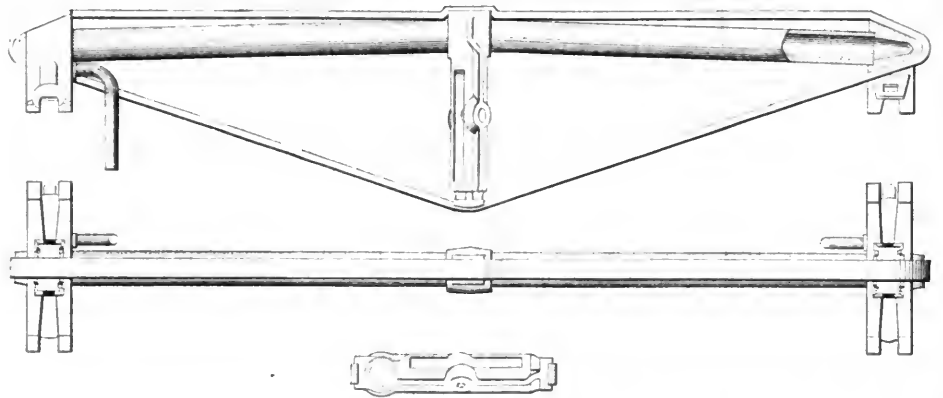
1. Within certain limits, which have so far not been reached in Europe, or even in America, raising the center of gravity of engines has nothing but good results. It results in decrease in the strain on the permanent way and on the parts which go to make up the engine, wheels, axles, boxes and frame plates. The running of the engines is made smoother because the springs come more into play under the action of lateral motion and in running round curves; the tendency to derailment is decreased by the increase of the load on the outer rail when curves are run over at a high rate of speed.

2. Raising the boiler seems to be the most practical, the most simple and the least costly method of increasing engine power, as it allows of the barrel having a diameter greater than the space between the ties.

3. As the boiler does not on the average make up more than about a quarter of the weight of an engine, if it be raised a given amount, the center of gravity of the whole is only raised about a quarter of this amount.

4. The center of gravity of the highest engines in use at present is much lower than that of passenger carriages and loaded wagons; it can therefore be considerably raised without fear of endangering safety.

What has been said above and the tendencies which from day to day become more marked, lead us to think that the future belongs to high engines, and that, cost what it may, we must endeavor to raise the boilers in order to make their power proportionate with the growing requirements of railway working, and with a view to decrease, in proportion as speed increases, the wear and tear on the permanent way.



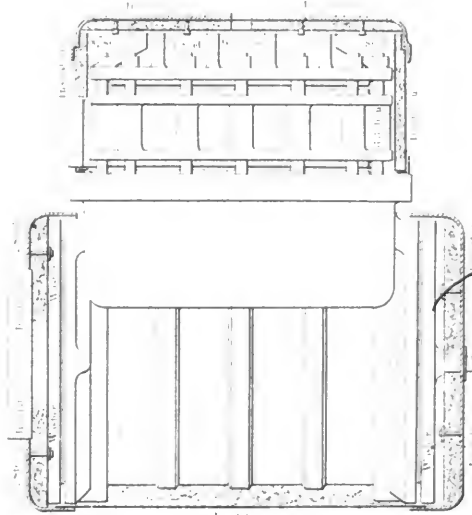
A New Brake-Beam.

A New Brake-Beam.

The accompanying illustration is a new brake-beam designed and patented by Mr. J. N. Barr, Superintendent of Motive Power of the Chicago, Milwaukee & St. Paul Railway. The compression member is of pipe and the tension member is a bar, rectangular in section, extending entirely around the compression member. The brake-heads are so made as to permit the tension member to be put on after it is formed into shape and welded. When heated and shrunk on it holds the heads firmly in place. The construction is exceedingly simple, and there is nothing about the beam to get out of order. It might possibly be argued that it could not be repaired on the road, but railroad men now appreciate the fact that metal beams should be repaired at the shops and not on the road. The beam is a few pounds heavier than some others because of the metal in the part of the truss back of the pipe, but that metal adds to the vertical stiffness of the beam, and is an advantage in that respect.

A Convenient Method of Jacketing Steam Chests and Cylinder Heads of Locomotives

Many railroad men realize the advantage to be derived from thoroughly jacketing the steam chests and cylinder heads of locomotives, but this is seldom done because of the inconvenience the insulation causes when repairs are to be made, or the steam chest cover and cylinder heads removed for any reason. On the Chicago and Northwestern Railway engines are fitted with insulation in a manner which overcomes this objection, as will be evident from



Method of Jacketing Steam Chests and Cylinder Heads—Chicago & Northwestern Railway.

the accompanying illustration. The cylinder head casings have 14 inches of insulating material (which we understand is asbestos) held to the inside of each by a disk of galvanized iron secured by studs, screwed into the casing. Evidently when the casing is removed, the insulation comes with it, and the workman would not know of its presence except for the increased weight of the casing.

The steam chest casing cover is provided with insulating material, secured in place in the same manner. The vertical sides of the casing are made double and the inner and outer sheets flanged toward each other, with the flange of the outer sheet under the other. The space between them is filled with asbestos and when the casing cover is on it is secure. The insulation on the back cylinder head is not so easily removed as that on the front one, but there is seldom occasion to disturb it. This matter of thoroughly jacketing all parts of a locomotive to which the heat of live steam is communicated is worthy of careful attention, for the saving to be effected at small outlay is considerable.

Trade Catalogues.

In 1891 the Master Car-Builders' Association, for convenience in the filing and preservation of pamphlets, catalogues, specifications, etc., adopted a number of standard sizes. These are given here in order that the size of the publications of this kind, which are noticed under this head, may be compared with the standards, and it may be known whether they conform thereto.

It seems very desirable that all trade catalogues published should conform to the standard sizes adopted by the Master Car-Builders' Association, and therefore in noticing catalogues hereafter it will be stated in brackets whether they are or are not of one of the standard sizes.

STANDARDS.	
For post card circulars.....	3½ inches by 6½ inches.
Pamphlet and trade catalogues.....	4½ inches by 6 inches.
Specifications and letter-paper.....	6 inches by 9 inches.
	12 inches by 12 inches.
	18 inches by 10½ inches.

LEAD LINED IRON PIPE COMPANY. Manufacturers of Standard Lead Lined Iron Pipe and Fittings. Wakefield, Mass. Price list No. 16. 46 pages, 5½ by 8½. (Not standard size.)

This company manufactures wrought iron pipes which are lined with lead, the latter intended to resist corrosion, and the outside iron casing giving the requisite strength to resist internal pressure. Lining a pipe with lead is not very difficult, but the company makes all the fittings, couplings, elbows, tees, etc., which are also lead lined, and in such a way that part of the thread for screwing the parts together is cut in the lead and part in the iron. Cuts are given showing sections of the pipes and fittings, with tables of their dimensions.

THE THOMPSON-RYAN, DIRECT CURRENT, MULTIPHASE, ELECTRIC GENERATOR. Built by J. H. McEwen Manufacturing Company, Haymeyer Building, New York Works, Ridgeway, Pa. 32 pages, 5½ by 8½ inches. (Not standard size.)

The frontispiece of this pamphlet is a half-tone engraving, made from a wash drawing of a works at Ridgeway, Pa. In the introduction it is said that the company has made arrangements with Prof. Harris J. Ryan, of Cornell University, and Milton E. Thompson, the inventors of the Thompson-Ryan dynamo, for its manufacture. This, it is said, "is replete with novelties," but "has long since passed the experimental stage, as is fully attested by a number of large sized machines now in constant operation under the most trying conditions." They then proceed to give a full description of these machines, and also add interior views of the works where they are made. Following, then, are half-tone illustrations showing generators driven by horizontal direct connected simple and compound and also vertical engines. The details of the generator are also fully explained and some of them illustrated with very excellent half-tone engravings. The full-page engraving all have ornamental borders, which, with the letter-press are printed in brown ink, the engravings being black. The paper and typography are all of the best.

ILLUSTRATED CATALOGUE AND PRICE LIST OF THE BOSTON GEAR WORKS. 31 Hartford Street, Boston, Mass. 40 pages 5½ by 8 inches. (Not standard size.)

In this little pamphlet the publishers describe various kind of small gears suitable for clock-work and very light machinery, and which doubtless will be useful to many of our readers, who, like ourselves, have often not known where such gears could be obtained. The different sizes, styles, etc., are illustrated and described by cuts and tables. "Intermittent gears," universal joint couplings, brass ratchets and pawls, inter level, crown, internal, elliptical and spiral gears, escape wheels, clutches, keys, small pulleys and hangers, chain and chain wheels, cotton worms and worm-gears, are all manufactured by this company and are described in the pamphlet before us. The company also manufacture gears for heavy machinery, but these, it is said, will be described in another catalogue.

No. 55, PRICE LIST, GALVANIZED STEEL WIRE, NETTINGS, WIRE FENCING, WIRE WINDOW AND DOOR SCREENS, ETC. By H. H. Wire Cloth Company, 17 Warren Street, New York. 28 pages, 3½ by 6 inches. (Standard size.)

This company manufactures steel wire netting for various purposes, cable for lightning rods, and fencing wire and ribbon fencing, wire window and door screens, etc., all of which are illustrated and described in the little volume before us, the only fault of which is that it is printed in blue ink.

MORRIS MACHINE WORKS. Builders of Centrifugal Pumping Machinery, Engines and Boilers. Baldwinville, N. Y. 32 pages, 6 by 9 inches. (Standard size.)

In the introduction to this catalogue the publishers say that "centrifugal pumps are constantly finding new favor

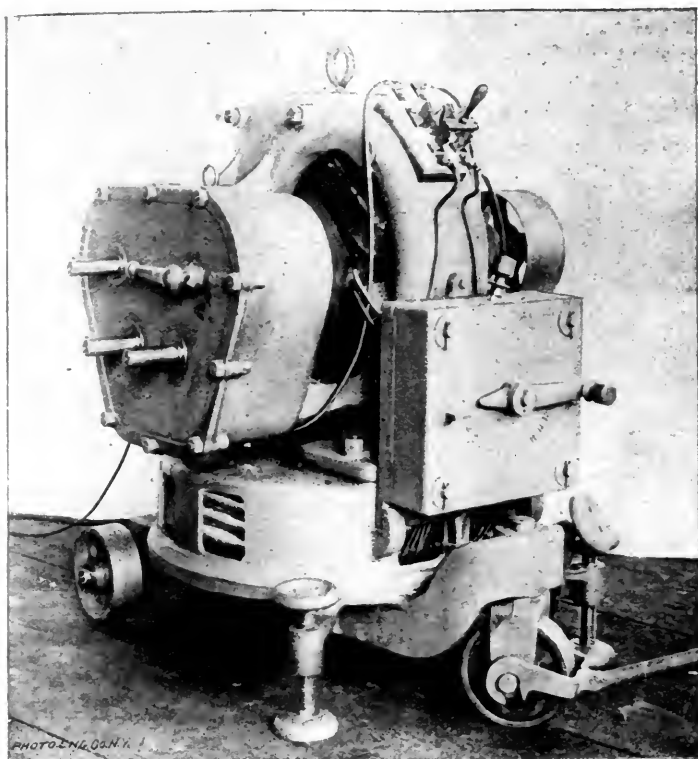


Fig. 1.

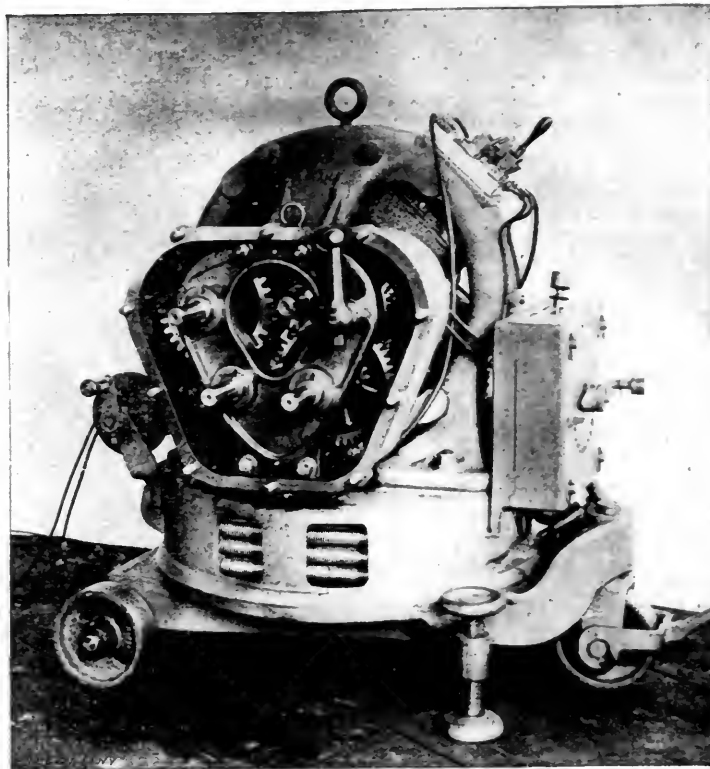


Fig. 2.

GIBBS' PORTABLE ELECTRIC MOTOR FOR SHOP USE.

from users, on account of their simplicity, durability, great capacity for handling material in large quantities, capability of pumping muddy and gritty water (which would shortly cut out any piston pump), their great economy of power under low lift and their low cost, which is anywhere from one-third to one-half that of any other type of pump."

In a following article the advantage of having a pump properly proportioned to the work which it must do is set forth and explained. Illustrations are then given of a large sewage pump with a direct connected engine, which is followed by an illustration and description of the different sizes of vertical pumps that is there, the shaft of which is in a vertical position. Several types of pumps, to be driven by belts, are then illustrated and described, and tables of drums of the different sizes are also given. This is followed by a curious diagram showing the position of the suction and discharge pipes of various patterns of pumps, 32 in all. It would hardly seem possible to place these pipes in so many different positions.

A number of illustrations follow, representing direct connected pumps, in which vertical engines are connected direct to the pump shaft. Several hydraulic dredging pumps to be driven by belts, and a portable pumping outfit and various details of these machines are shown.

The wood engravings are all excellent and the typography equally so, and the whole makes a very attractive volume.

The Gibbs Portable Electric Motor for Machine Shop and Round-House Work.

In shops where electricity is used for lighting and power purposes, portable electric motors can be used to advantage in the same lines of work that steam and compressed air motors are so frequently employed. In many situations they present superior advantages, because of the ease with which they can be connected to receive power, flexible wire cables taking the place of iron pipes for steam or air, and from the fact that there is no exhaust to be taken care of.

The Gibbs Electric Company, of Milwaukee, Wis., has recently designed and built a number of portable motors for general machine shop work, from photographs of which the accompanying illustrations were made. It is the intention to use these motors with Stow or other flexible shafts for such work as boring cylinders, facing valve seats, drilling staybolts, tapping sheets for staybolts, and general round-house and machine shop work, in which motors can take the place of man power with economy.

Figs. 1 and 2 are both rear views of the motor mounted on a three-wheeled truck, Fig. 1 showing it complete, while in Fig. 2 the cover of the spindle case is removed. The commutator is on the further end of the armature shaft, and the pulley adjacent to it, which can be seen in Fig. 1, is used for belting direct to machine tools. Fig. 2, which is taken from a slightly different position, shows at the left a cable reel, on which is wound about 100 ft. of cable, allowing the motor to be moved within a radius of about 100 ft. from the supply of current. On the end of the cable is a plug, which can be inserted into sockets at

various points in the shop, so that the tools can be taken anywhere and receive power.

The motor is mounted on a round base, which in turn is mounted on the truck proper on a center pin. The round base is in the form of a turn-table, so that the motor can be swung around to suit the work. In this round base is placed the resistance coils, which vary the speed of the motor.

The box, or gear case, containing the drill spindles, is shown in both illustrations, Fig. 2 having the cover removed to show the gearing. The three spindles run at 177, 98 and 40 revolutions respectively. These speeds can, of course, be changed to suit any requirements which it may be necessary to meet. It may be noticed that there is a handle on the spindle box, similar to that used on the back gearing of lathes. When it is desired to use the pulley only, the gearing is by means of this handle thrown out of clutch, and the wear on the same is avoided.

On the right hand side, in both of our figures, is shown the main switch and controlling box with reversing switch. The reversing switch lever is seen projecting through the top of the box, and is interlocked with the controlling lever, so that it is impossible to reverse the motor unless it is first stopped. The resistance coils in the base will vary the speed of the motor from 900 to about 450 revolutions per minute, thus, of course, reducing the speed of the spindles proportionately.

When at work the motor is steadied by the two screws bearing on the floor, and the handle for hauling it about the shop can be taken off so as to be out of the way.

Everything about the motor is made on jigs and templates and is interchangeable. The gearing is the best obtainable. All the spindle bearings are exceedingly large, and, as the motor is run in oil, perfect lubrication is obtained. The motor is five horse-power, and is sufficiently large to drive any ordinary machine tool found in railroad shops. The spindle running at 177 revolutions is intended for tapping in staybolts, and it has been found that it is possible to run staybolt taps at this speed. The other two speeds are for cylinder boring and valve-seat facing. If it is desired to use the spindles for running-rope drives, a pulley can be put on any one of them, the advantage of this being that the spindles are so reduced in speed that no countershaft is necessary.

The weight of this motor complete is 1,400 pounds, but, on account of its construction, is readily moved about the shop by one man. Everything about the motor, gearing and truck is of the best, and no expense has been spared in making the tool as perfect as possible.

The Becker Vertical-Spindle Milling Machine.

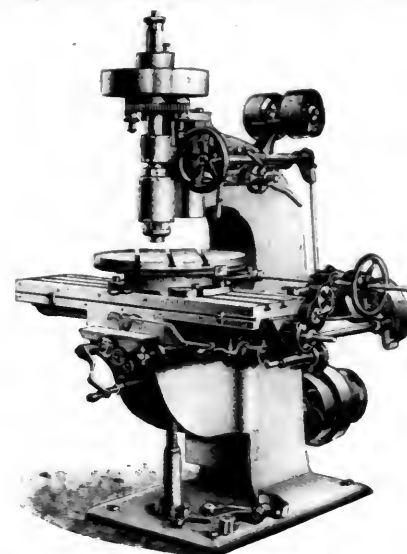
In the accompanying illustration we show an interesting vertical-spindle milling machine made by the John Becker Manufacturing Company, of Fitchburg, Mass. It is claimed for this machine, which is known as No. 5, that it is more practical, is of greater adaptability and has more labor-saving qualities than any horizontal spindle mill on the market. As a boring mill it is in many respects superior to the drill press.

The frame is heavy and very rigid, and is therefore suitable for heavy cuts. The spindle has long bearings running in bronze boxes that are adjustable for wear. The lower

end of it is threaded for chucks or large face mills. The shanks of end mills are secured by the drawbar which passes through the center of the spindle. To get rid of end play, the lower bearing is provided with ball thrust bearings at both ends, thus reducing friction and securing a level surface when using face mills. The driving pulley of the spindle is 15 inches diameter and 3 inches face, and double back-geared 5 to 1. It is independently mounted to secure the permanent alignment of the spindle. This is a valuable feature on a vertical spindle milling machine, as without it the spindle is eventually worn out of alignment, impairing the general usefulness of the machine, by making the use of large surface mills impracticable, for obvious reasons.

The head has a vertical traverse of seven inches automatically and with automatic release. It is provided with a stop gage graduated to thousandths of an inch.

The knee has a vertical adjustment of 18 inches, and the greatest possible distance between table and spindle is 21 inches. The table is 48 by 13 inches (working surface), and has an automatic feed of 40 inches. The saddle, which is the same length as the table, has a cross feed of 13 inches. The



The Becker Milling Machine.

rotary attachment, with an automatic feed in either direction, is found to be an exceedingly useful feature. The table is 22 inches in diameter and will swing 34 inches.

The table has six changes of straight and rotary feed for each change in speed. An arbor support, attached to the knee, is provided for use with long arbors for slab or straddle milling. Gripping jaws, 9 inches by 2 inches, fitting the slots in the table, also accompany the machine.

The workmanship and materials are guaranteed to be of the best and no pains are spared to make it a reliable and accurate machine. A glance at the illustration shows it to be a handy and convenient tool for many kinds of work. In drilling and boring work it has a large range and the rotary feed makes it possible to mill out large holes with great accuracy. The machine complete with countershaft weighs about 4,300 pounds.

The success of this tool has been remarkable not only in this country but also abroad. A firm in Budapest, Hungary, are using two of them and has just ordered a third.

The Use of Electricity in the Brooks Locomotive Works.

In 1881 the Brooks Locomotive Works purchased two five-arc light and three 10-arc light dynamos for illuminating its works and from the small beginning thus made, the use of electricity has spread until it is used for light and power in nearly every department of the plant. In 1888 an incandescent light plant was installed, but it was not until 1892 that the current was used for power purposes. Then two power generators were put in service to furnish current for overhead cranes in the boiler shop and foundry, and in 1894 the uses of the current, actual or prospective, were so numerous that it was decided to concentrate the generating plant and a contract was made with the Western Electric Company, for one 200-horse power and one 100-horse power generator. These generators supplanted all other apparatus and now operate 80 arc lamps, 450 incandescent lamps, and furnish electricity for one 35-horse power motor to run shafting in iron foundry; one 30-horse power motor for transfer table; one 25-horse power motor for the bending rolls in the boiler shop; one 10-horse power motor for the shafting in pattern shop; one 6-horse power motor for elevator in iron foundry; two 5-horse power motors for punch and shears in boiler shop; one 40-horse power motor for shafting in boiler shop; one 21-horse power motor for bar iron shears, in blacksmith shop; one 20-ton electric traveling crane in boiler shop and two 10-ton electric traveling cranes in foundry. The larger crane in the boiler shop is equipped with two 20-horse power motors and one 6-horse power motor, and the two smaller cranes are each equipped with two 10-horse power motors and one 6-horse power. There are eight electric motors connected with the foundry; six on the cranes, one running the shafting and fans, and one running the elevator.

The two generators furnish power for all motors, driving shafting and isolated machine tools, also current for all arc and incandescent lamps now in service. The arc lights throughout the plant are wired four in series, thus enabling any group of four lamps to be operated at will.

The electric building is new and attached to the east side of the boiler house. Upon entering it, the first thought is of its spaciousness, neatness and order. It has a granolithic floor and the conduits are covered by iron. The two generators, one 200 horse power and the other 100 horse power, are driven by two Buckeye engines directly connected. The steam pipes are all covered with asbestos and jacketed with Russia iron, with polished brass bands. From the generators the current is conducted through lead-covered cables to a large switch board, through a conduit of brick laid in Port-

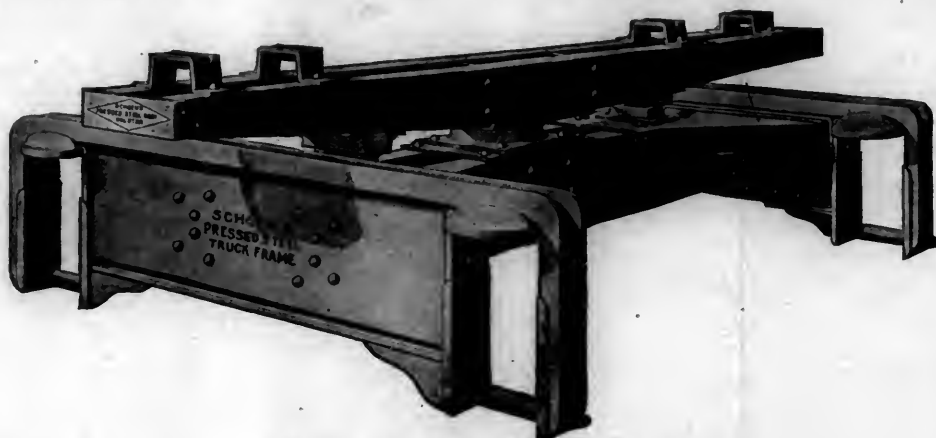
test the middle pair of wheels in a six-wheel truck were exchanged in five minutes and twenty seconds. By the old method this exchange would have required at least two hours' time.

In the round house wheels are taken from locomotives in the same manner, in from thirty to forty-five minutes, a saving of over three hours.

In repairing engines the Baird rotary drilling machine is

over the pedestal bolt. They will last a long time and can be renewed for a few cents.

The transoms are composed of channel-shaped sections placed with the flanges toward each other. They rest on top of the lower flange of the side plates and have their ends stamped outwardly to form brackets by which they are secured to the side plates. The transoms are tied together by vertical braces, and under the center plate is a spacing



The Schoen Pressed Steel Trucks for Freight Cars.

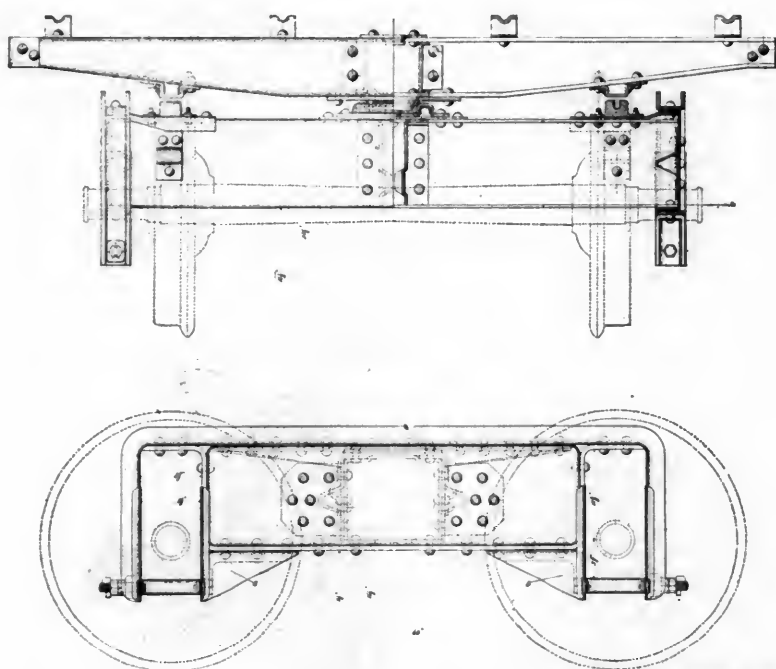
used, which is worked by the same power. Holes are tapped in a firebox by this method, and flues are rolled and caulked, using a pneumatic hammer which strikes 250 blows a minute, thus doing what was always thought to be impossible—clipping and caulking by other than hand labor. It is but the work of an instant to jack up a freight car, set it on blocking made for the purpose, and take out the truck for repairs. Air pipes are bent in standard shapes by use of air cylinders and dies. Car roofs are torn off by air machines, and car sills are pulled down by an air jack and new ones put back by the same power.

A simple means of delivering oil is in use in the yards. A reservoir close to the oil house is filled with oil, which is forced through underground pipes to any oiling station in the yard in an instant. The pipe is nearly a mile long.—*The Southwest Railway Record.*

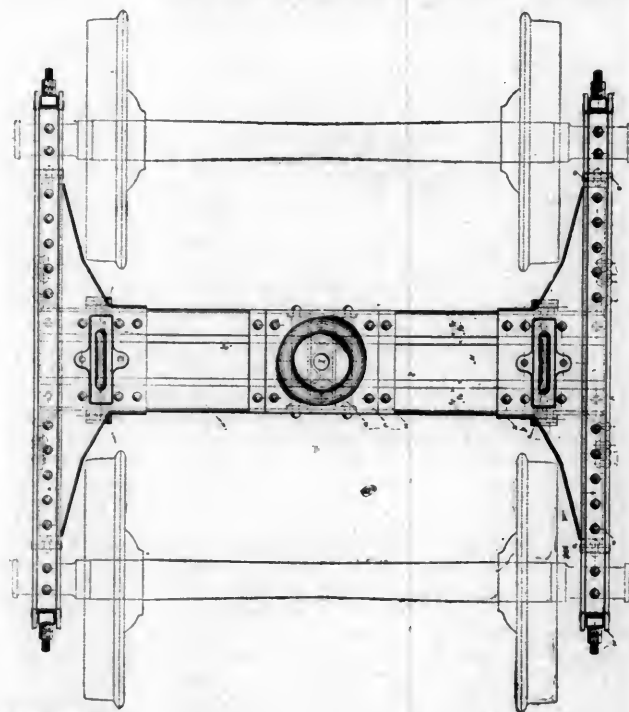
plate that greatly aids them in resisting transverse strains. To keep the truck square gusset plates extend from the inner jaws of the pedestals to points well out on the transoms.

The body bolster shown should really be considered as inseparable from the metal truck, for one of the several advantages of the truck is the stiffness obtainable; but this freedom from deflection, unattainable with a wooden truck bolster, will not keep side bearings entirely out of contact unless there is used in connection with the truck an unyielding body bolster.

There are several advantages for making the side frame of several pieces instead of a single one. In the first place the top and bottom chords of the truss need not be made of the same thickness as the plate, but can be of such sizes and sections as are requisite for strength independently of any



The Schoen Pressed Steel Truck for Freight Cars.



The Schoen Pressed Steel Truck for Freight Cars.

To meet the demand for a more substantial freight car truck, the Schoen Pressed Steel Company, of Pittsburgh, has brought out a pressed steel truck, shown in outline and perspective in the accompanying illustrations.

The designer started out with the decision to put the springs over the journal boxes, and to make a truck that, besides being reasonable in first cost, will be inexpensive to maintain. The side frame is composed of a top compression member in the form of an inverted channel and a bottom tension member consisting of a bar of 4 by 1/2 inches iron. Between these there is a pressed steel plate with all of its edges flanged inwardly. These flanges supplement the strength of the compression and tension members. The parts are riveted together with hydraulic power.

The ends of the compression members are turned down to form the outer jaws of the pedestals, and the inner jaw is riveted into place as shown. At the bottom they are held in proper relation to each other by a thimble and heavy bolt provided with two nuts and a split key. The faces of the jaws are protected against wear from the journal boxes by chafing plates. These are thin and light and have a rectangular hole near the bottom which permits them to be fitted

considerations of the size or weight of the plate itself. It also facilitates the construction of the pedestals in a substantial but inexpensive manner. Again, it makes it possible to repair the frame in a railroad shop if it has been distorted in an accident, and does not necessitate re-forming the whole side in the original dies with the attendant delays and freight charges.

A few of the claims made for this design are: Increased car mileage; a saving in dead weight; a saving in flange wear on wheels and wear on rails because the truck is kept square; repairs can be made in the railroad shops; a reduction of cost of repairs to a minimum; and the avoidance of such hot boxes as are caused by frames getting out of square. The material is a special grade of mild steel, which the extensive experience of the Schoen Pressed Steel Company has shown to be best adapted for work of this character.

A Pneumatic Riveter for Shipyards.

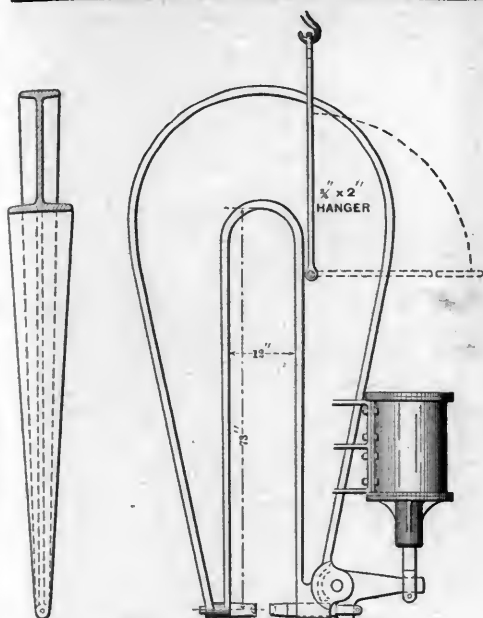
The Baird Portable Machine Company of Topeka, Kan., are known to many of our readers through the various pneumatic tools built by them and specially adapted for use in railroad shops. But the demand for pneumatic

land cement, and covered with cast-iron plates, laid in cement, which renders the conduit watertight. From the switch board the current is distributed throughout the works.

Use of Compressed Air.

The repair shop of the Atchison, Topeka & Santa Fe at Argentine, Kan., has been fitted up very extensively with pneumatic tools. In the passenger car department the broom and duster and the rattan beater have been thrown away, and the cars are cleaned by the use of compressed air, which is piped through the yard. The laborer simply attaches a hose and turns on the air, and the cars are cleaned much more thoroughly than broom or duster can do it, as the air gets behind every steam pipe and all blinds and ventilators, where it would be impossible to clean by other means. The medical department regards the system the greatest microbe destroyer known.

By the same power wheels are taken from under coaches with a pneumatic jack, a drop pit being used, into which the wheels are dropped. Only the weight of the wheels is handled, instead of the weight of the whole car. At a recent



Pneumatic Riveter for Shipyards.

riveters, punches, etc., is not confined to railroad circles, for the company has just furnished the Chicago Ship Building Company the large riveting machine which we illustrate in the accompanying engraving. It has a 73-inch throat and a 12-inch gap, and has been designed especially for shipyard work.

The air cylinder is about 12 inches in diameter and is mounted on a shelf cast on the frame. It operates through a bell-crank lever fulcrumed on the frame. Instead of pin connections at the ends of the lever, these ends bottom in jaws in the piston rod and riveting plunger, and are held in position during the return stroke by comparatively small pins inserted in the jaws outside of the lever.

The machine is suspended by a hanger, on which it is so balanced as to be easily worked in either the vertical or horizontal positions, or at intermediate angles. This is only one example of the special tools which this company has furnished or is prepared to build for parties whose work is of such a character as to require them.

The Q. & C. Perfection Oil Purifier.

The Q. & C. Company, of Chicago, has recently added to its line of specialties the oil purifier which we show in the accompanying sectional engraving. It consists of a cylindrical casing having a short, open-top cylinder inside of it riveted to the bottom, and a large pan placed inside the casing, and having a central tube extending down from it into the cylindrical shaped vessel at the bottom. This tube carries a bell-shaped vessel which covers the cylindrical one, but without touching it at any point. A cover on top

of the top of the lower glass, which point is indicated by the words "water line" in our illustration. Steam is then turned on at valves 4 and 5 until the temperature of the water rises to about 115 or 120 degrees, after which valve 4 is closed and valve 5 regulated to maintain that temperature. Oil to be cleaned is then poured into the pan slowly, and as it descends it is heated and thereby thinned and made to give up much of its impurities, the process of purifying being completed by its passage through the water. Its course is to pass down through the central tube into the water, through which it rises, and then, passing over the top of the cylindrical vessel, goes down between it and the bell-shaped vessel; from thence it is liberated through perforations in the lower flange of the bell and rises through the water a second time to collect on top of it and be drawn off through faucets 6 or 3. In practice the purified oil is kept at about the height shown



The Q. & C. Perfection Oil Purifier.

in our illustration and when any great quantity is drawn off oil to be cleaned is fed into the pan to take its place.

The purifier does not require cleaning oftener than once in six to twelve months. To clean it, faucet 6 is opened and all the clean oil drawn off, water being poured into the apparatus at the pan to make all of the oil rise to that faucet. Then a full head of steam is turned on at valve 4 and the dirty oil and water will rush out of faucets 1 and 2 when they are opened.

The purifiers have been used long enough to be heartily endorsed by many concerns that have them in service at their shops. They are simple and inexpensive, easily operated, and use a washing medium that does not clog up or waste any of the oil. Only one caution is given, which is to be careful not to overheat the oil, as too much heat makes it thick and spoils it. The purifiers work equally well with all grades of oil and effect a great saving. They are made in 25, 50, 80, 100, 150, 225 and 300 gallon sizes, which have a filtering capacity every 24 hours of 1, 3, 5, 8, 10, 15 and 20 gallons respectively. From these figures it will be seen that besides acting as filters they afford a large storage capacity. Any special sizes wanted can be furnished at short notice. Further information will be supplied by the Q. & C. Company, Western Union Building, Chicago, Ill.

Riehle Abrasion Testing Machine.

The Riehle abrasion testing machine, shown herewith, is an apparatus 25 inches high, 29 inches wide, 34 inches long, and weighs about 350 pounds. It is arranged to take specimens of 1-inch cube or smaller, and can be arranged to take 2-inch cubes also.

The apparatus consists of a revolving disk on a vertical spindle. It is geared three to one, and the disk is fitted with a hardened steel grinding plate. Above this plate a horizontal arm is arranged capable of sliding backward and forward and carrying at one end a 1-inch cube, or other shape, to be subjected to abrasion. This arm also carries a weighted lever or graduated beam capable of loading the abrasion specimen as high as 200 pounds. The spindle of machine is made to revolve by the bevel gears and 10-inch pulleys, as shown, and an extra pair of gears of unequal size give motion by cam and pin to the lever arm, which moves the horizontal arm backward and forward over the grinding disk. The apparatus is also furnished with revolution counter for indicating number of revolutions during test, and with a sandbox and water duct for furnishing grinding material. A brush or scraper may be used to clean the disk if desired. It is intended to run the pulleys at about 150 to 175 revolutions, giving 50 or more revolutions of the grinding disk. It is also intended that the lateral movement combined with the revolution will distribute the wear uniformly over a large part of the surface of the disk. The flange of

the main frame is arranged to protect the gearing, and a spout at one part carries off surplus sand and water.

The machine was made for the Cambria Iron Company, and is in use by them at Johnstown, Pa. It was built by Riehle Brothers, Philadelphia, Pa.

The Dickerman Twenty-inch Tool Grinder.

The accompanying illustration shows a new 20-inch tool grinder made by the Dickerman Emery Wheel and Machine Company, of Bridgeport, Conn. It is neat and substantial in design, convenient for the operator and confines the water to the right place. The water pan may be quickly drawn through the door in front of the base when it is necessary to clean it, then be placed back in machine and refilled by pouring fresh water into the table, where it will run down into the pan below. The round table in front of the wheel permits the operator to always be at the same convenient distance from the emery wheel, in whatever position he wishes to hold the tool when grinding.

The hood is in one piece except the front, which with the tool rest is adjustable to the wear of the wheel. The emery wheel being encased and with this company's special device inside the hood, water and spray are kept from the emery wheel collars, bearings and floor, and the interior arrangement of the machine is such that no water can get on the floor, inside of the base.

The emery wheel collars are dovetailed and fitted with a device for balancing the wheel. These collars and all other running parts of the machine are turned inside and out, and dust collars are used to keep all water and dirt from



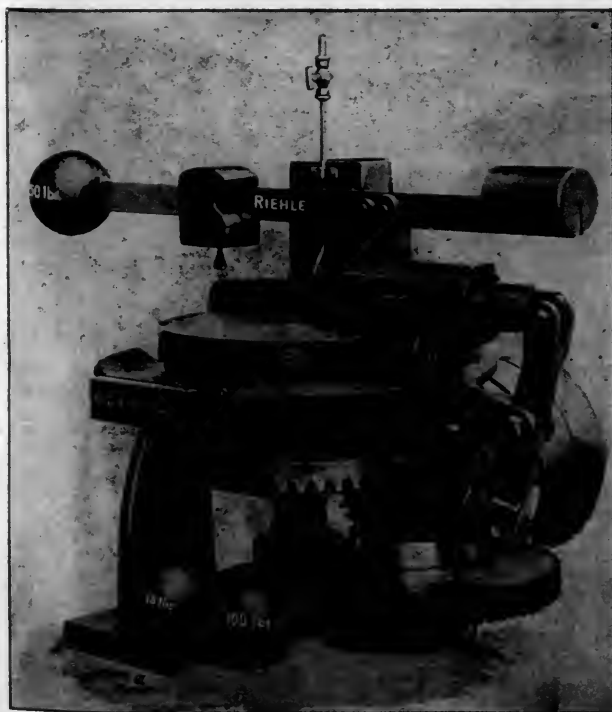
The Dickerman 20-Inch Tool Grinder.

the bearings. This machine being equipped with long self-oiling bearings and a large spindle runs very smoothly. The wheel is 20 inches diameter and 2½ inches or 3 inches face. The diameter of the spindle is 2 inches; the boxes are each 6½ inches long, the spindle pulley 6 inches in diameter and 3½ inches face; the height from the floor to the center of spindle is 36 inches; the foot of base is 20 by 30 inches, and the total floor space occupied is 28 by 35 inches.

Lidgerwood Cableways for the Panama Canal.

Spencer Miller, M. E., engineer of the department of hoisting and conveying machinery of the Lidgerwood Manufacturing Company, New York City, who recently went abroad in the interests of that company, has just closed a contract with the Compagnie Nouvelle Du Canal De Panama at Paris, for seven Lidgerwood cableways, to be used on the Panama Canal. This company is one which has recently been formed to complete the great Panama Canal, and the seven cableways will be used exclusively for earth excavating. They will be equipped with all the latest improvements, including the patent aerial dump, which is such an important feature of these machines, the apparatus throughout being similar in construction to the 20 Lidgerwood cableways used on the Chicago Main Drainage Canal, except that the Panama cableways will have fixed towers and anchorages. The spans will range from 250 to 300 feet.

This order was not placed until after a most careful and extended investigation had been made of the various apparatus available for canal excavating purposes. Engineers were sent by the Compagnie Nouvelle Du Canal De Panama from Paris to examine the Lidgerwood cableways and other excavating machinery in use at Chicago on the canal there building. The result of their investigation was a most flattering report in favor of the Lidgerwood cableways, and the negotiations then begun have resulted in the large order secured by Mr. Miller. This is one of the largest single orders for cableways of any description ever received by any concern in this country from abroad, and points to a world-wide appreciation of the merits of the Lidgerwood cableway.



Riehle Abrasion Testing Machine.

of the casing closes the apparatus. Two gage glasses A B and C D are provided, also a steam coil which takes steam at 5, a steam pipe with an admission valve 4, and faucets 1, 2, 3 and 6.

The operation of the purifier is as follows: Water is poured into the upper pan until it rises to within two inches

The Use of Electricity in the Brooks Locomotive Works.

In 1881 the Brooks Locomotive Works purchased two five-are light and three 10 are light dynamos for illuminating its works and from the small beginning thus made, the use of electricity has spread until it is used for light and power in nearly every department of the plant. In 1888 an incandescent light plant was installed, but it was not until 1892 that the current was used for power purposes. Then two power generators were put in service to furnish current for overhead cranes in the boiler shop and foundry, and in 1894 the uses of the current, actual or prospective, were so numerous that it was decided to concentrate the generating plant, and a contract was made with the Western Electric Company, for one 200-horse power and one 100-horse power generator. These generators supplanted all other apparatus and now operate 80 arc lamps, 150 incandescent lamps, and furnish electricity for one 35-horse power motor to run shafting in iron foundry; one 30-horse power motor for transfer table; one 25-horse power motor for the bending rolls in the boiler shop; one 10-horse power motor for the shafting in pattern shop; one 6-horse power motor for elevator in iron foundry; two 5-horse power motors for punch and shears in boiler shop; one 10-horse power motor for bending in boiler shop; one 21-horse power motor for bar iron shears, in blacksmith shop; one 20-ton electric traveling crane in boiler shop and two 10-ton electric traveling cranes in foundry. The larger crane in the boiler shop is equipped with two 20-horse power motors and one 6-horse power motor, and the two smaller cranes are each equipped with two 10-horse power motors and one 6-horse power. There are eight electric motors connected with the foundry; six on the cranes, one running the shafting and fans, and one running the elevator.

The two generators furnish power for all motors, driving shafting and isolated machine tools, also current for all arc and incandescent lamps now in service. The arc lights throughout the plant are wired four in series, thus enabling any group of four lamps to be operated at will.

The electric building is new and attached to the east side of the boiler house. Upon entering it, the first thing is of its spaciousness, neatness and order. It has a granolithic floor and the conduits are covered by iron. The two generators, one 200-horse power and the other 100-horse power, are driven by two Buckeye engines directly connected. The steam pipes are all covered with asbestos and jacketed with Russia iron, with polished brass bands. From the generators the current is conducted through lead covered cables to a large switch board, through a conduit of brick laid in Port

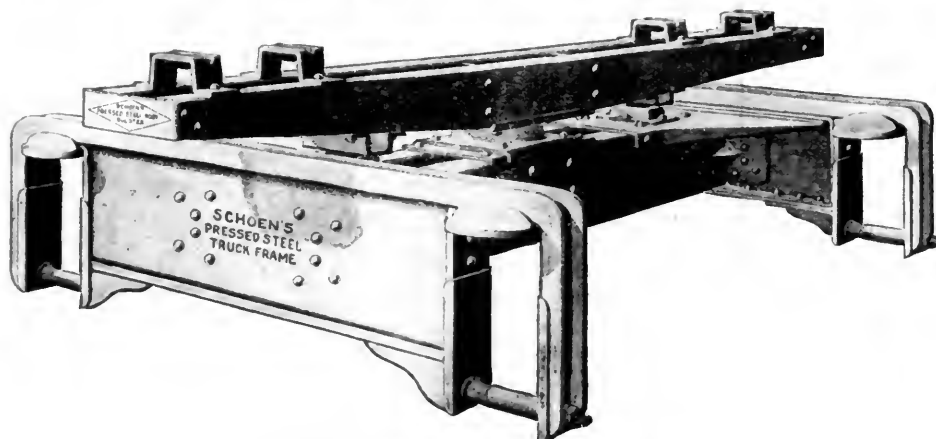
test the middle pair of wheels in a six-wheel truck were exchanged in five minutes and twenty seconds. By the old method this exchange would have required at least two hours' time.

In the round house wheels are taken from locomotives in the same manner, in from thirty to forty-five minutes, a saving of over three hours.

In repairing engines the Baird rotary drilling machine is

over the pedestal bolt. They will last a long time and can be renewed for a few cents.

The transoms are composed of channel-shaped sections placed with the flanges toward each other. They rest on top of the lower flange of the side plates and have their ends stamped outwardly to form brackets by which they are secured to the side plates. The transoms are tied together by vertical braces, and under the center plate is a spacing



The Schoen Pressed Steel Trucks for Freight Cars.

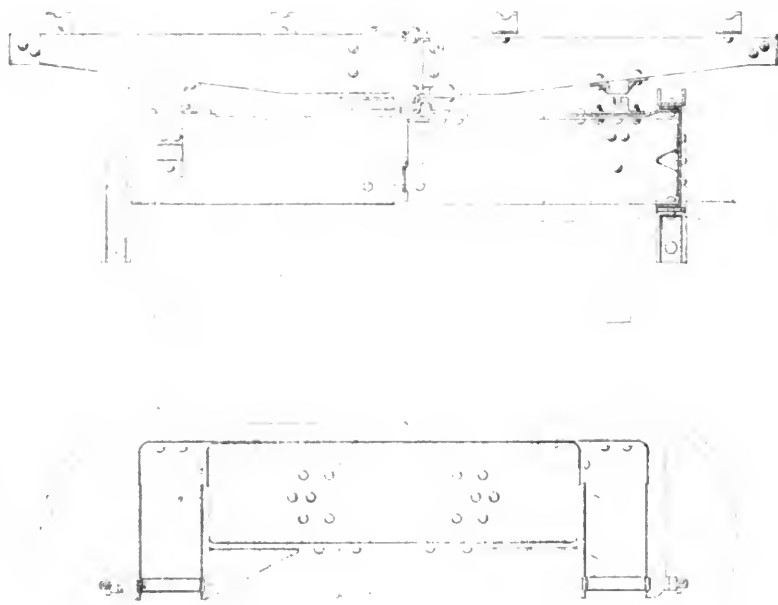
used, which is worked by the same power. Holes are tapped in a firebox by this method, and flues are rolled and caulked, using a pneumatic hammer which strikes 250 blows a minute, thus doing what was always thought to be impossible—clipping and caulking by other than hand labor. It is but the work of an instant to jack up a freight car, set it on blocking made for the purpose, and take out the truck for repairs. Air pipes are bent in standard shapes by use of air cylinders and dies. Car roofs are torn off by air machines, and car sills are pulled down by an air jack and new ones put back by the same power.

A simple means of delivering oil is in use in the yards. A reservoir close to the oil house is filled with oil, which is forced through underground pipes to any oiling station in the yard in an instant. The pipe is nearly a mile long. *The Southwestern Railway Record.*

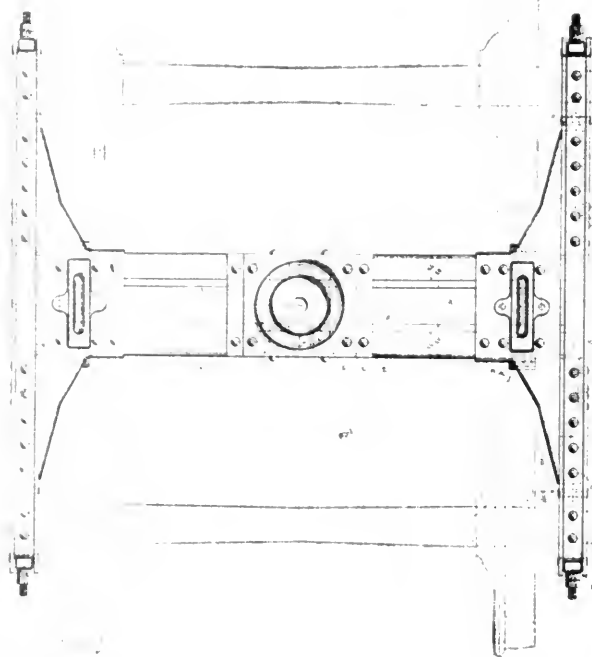
plate that greatly aids them in resisting transverse strains. To keep the truck square gusset plates extend from the inner jaws of the pedestals to points well out on the transoms.

The body bolster shown should really be considered as inseparable from the metal truck, for one of the several advantages of the truck is the stiffness obtainable; but this freedom from deflection, unattainable with a wooden truck bolster, will not keep side beams entirely out of contact unless there is used in connection with the truck an unyielding body bolster.

There are several advantages for making the side frame of several pieces instead of a single one. In the first place the top and bottom chords of the truss need not be made of the same thickness as the plate, but can be of such sizes and sections as are requisite for strength independently of any



The Schoen Pressed Steel Truck for Freight Cars.



The Schoen Pressed Steel Truck for Freight Cars.

land cement, and covered with cast iron plates, laid in cement, which renders the conduit watertight. From the switch board the current is distributed throughout the works.

Use of Compressed Air.

The repair shop of the Atchison, Topeka & Santa Fe at Argentine, Kan., has been fitted up very extensively with pneumatic tools. In the passenger car department the broom and duster and the rattan beater have been thrown away, and the cars are cleaned by the use of compressed air, which is piped through the yard. The laborer simply attaches a hose and turns on the air, and the cars are cleaned much more thoroughly than broom or duster can do it, as the air gets behind every steam pipe and all blinds and ventilators, where it would be impossible to clean by other means. The medical department regards the system the greatest microbe destroyer known.

By the same power wheels are taken from under coaches with a pneumatic jack, a drop pit being used, into which the wheels are dropped. Only the weight of the wheels is handled, instead of the weight of the whole car. At a recent

To meet the demand for a more substantial freight car truck, the Schoen pressed Steel Company, of Pittsburgh, has brought out a pressed steel truck, shown in outline and perspective in the accompanying illustrations.

The designer started out with the decision to put the springs over the journal boxes, and to make a truck that, besides being reasonable in first cost, will be inexpensive to maintain. The side frame is composed of a top compression member in the form of an inverted channel and a bottom tension member consisting of a bar of 1 by 3 inches iron. Between these there is a pressed steel plate with all of its edges flanged inwardly. These flanges supplement the strength of the compression and tension members. The parts are riveted together with hydraulic power.

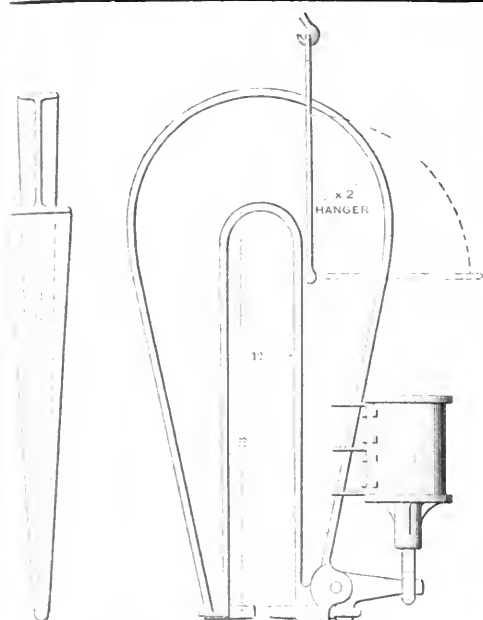
The ends of the compression members are turned down to form the outer jaws of the pedestals, and the inner jaw is riveted into place as shown. At the bottom they are held in proper relation to each other by a thimble and heavy bolt provided with two nuts and a split key. The faces of the jaws are protected against wear from the journal boxes by chafing plates. These are thin and light and have a rectangular hole near the bottom which permits them to be fitted

considerations of the size or weight of the plate itself. It also facilitates the construction of the pedestals in a substantial but inexpensive manner. Again, it makes it possible to repair the frame in a railroad shop if it has been distorted in an accident, and does not necessitate re-forming the whole side in the original dies with the attendant delays and freight charges.

A few of the claims made for this design are: Increased car mileage; a saving in dead weight; a saving in flange wear on wheels and wear on rails because the truck is kept square; repairs can be made in the railroad shops; a reduction of cost of repairs to a minimum; and the avoidance of such hot boxes as are caused by frames getting out of square. The material is a special grade of mild steel, which the extensive experience of the Schoen Pressed Steel Company has shown to be best adapted for work of this character.

A Pneumatic Riveter for Shipyards.

The Baird Portable Machine Company of Topeka, Kan., are known to many of our readers through the various pneumatic tools built by them and specially adapted for use in railroad shops. But the demand for pneumatic



Pneumatic Riveter for Shipyards.

Riveters, punches, etc., is not confined to railroad circles, for the company has just furnished the Chicago Ship Building Company the large riveting machine which we illustrate in the accompanying engraving. It has a 73-inch throat and a 12-inch gap, and has been designed especially for shipyard work.

The air cylinder is about 12 inches in diameter and is mounted on a shelf cast on the frame. It operates through a bell-crank lever interlocked on the frame. Instead of pin connections at the ends of the lever, these ends bottom in jaws in the piston rod and riveting plunger, and are held in position during the return stroke by comparatively small pins inserted in the jaws outside of the lever.

The machine is suspended by a hanger, on which it is balanced as to be easily worked in either the vertical or horizontal positions, or at intermediate angles. This is only one example of the special tools which this company has furnished or is prepared to build for parties whose work is of such a character as to require them.

The Q. & C. Perfection Oil Purifier.

The Q. & C. Company, of Chicago, has recently added to its line of specialties the oil purifier which we show in the accompanying sectional engraving. It consists of a cylindrical casing having a short, open-top cylinder inside of it riveted to the bottom, and a large pan placed inside the casing, and having a central tube extending down from it into the cylindrical shaped vessel at the bottom. This tube carries a bell-shaped vessel which covers the cylindrical one, but without touching it at any point. A cover on top

of the top of the lower glass, which point is indicated by the words "water line" in our illustration. Steam is then turned on at valves 4 and 5 until the temperature of the water rises to about 115 or 120 degrees, after which valve 4 is closed and valve 5 regulated to maintain that temperature. Oil to be cleaned is then poured into the pan slowly, and as it descends it is heated and thereby thinned and made to give up much of its impurities, the process of purifying being completed by its passage through the water. Its course is to pass down through the central tube into the water, through which it rises, and then, passing over the top of the cylindrical vessel, goes down between it and the bell-shaped vessel: from thence it is liberated through perforations in the lower flange of the bell and rises through the water a second time to collect on top of it and be drawn off through faucets 6 or 3. In practice the purified oil is kept at about the height shown



The Q. & C. Perfection Oil Purifier.

in our illustration and when any great quantity is drawn off oil to be cleaned is fed into the pan to take its place.

The purifier does not require cleaning oftener than once in six to twelve months. To clean it, faucet 6 is opened and all the clean oil drawn off, water being poured into the apparatus at the pan to make all of the oil rise to that faucet. Then a full head of steam is turned on at valve 4 and the dirty oil and water will rush out of faucets 1 and 2 when they are opened.

The purifiers have been used long enough to be heartily endorsed by many concerns that have them in service at their shops. They are simple and inexpensive, easily operated, and use a washing medium that does not clog up or waste any of the oil. Only one caution is given, which is to be careful not to overheat the oil, as too much heat makes it thick and spoils it. The purifiers work equally well with all grades of oil and effect a great saving. They are made in 25, 50, 80, 100, 150, 225 and 300 gallon sizes, which have a filtering capacity every 24 hours of 1½, 3, 5, 8, 10, 15 and 20 gallons respectively.

From these figures it will be seen that besides acting as filters they afford a large storage capacity. Any special sizes wanted can be furnished at short notice. Further information will be supplied by the Q. & C. Company, Western Union Building, Chicago, Ill.

Riehle Abrasion Testing Machine.

The Riehle abrasion testing machine, shown herewith, is an apparatus 25 inches high, 20 inches wide, 31 inches long, and weighs about 350 pounds. It is arranged to take specimens of 1-inch cube or smaller, and can be arranged to take 2-inch cubes also.

The apparatus consists of a revolving disk on a vertical spindle. It is geared three to one, and the disk is fitted with a hardened steel grinding plate. Above this plate a horizontal arm is arranged capable of sliding backward and forward and carrying at one end a 1-inch cube, or other shape, to be subjected to abrasion. This arm also carries a weighted lever or graduated beam capable of loading the abrasion specimen as high as 200 pounds. The spindle of machine is made to revolve by the bevel gears and 10-inch pulleys, as shown, and an extra pair of gears of unequal size give motion by cam and pin to the lever arm, which moves the horizontal arm backward and forward over the grinding disk. The apparatus is also furnished with revolution counter for indicating number of revolutions during test, and with a sandbox and water duct for furnishing grinding material. A brush or scraper may be used to clean the disk if desired. It is intended to run the pulleys at about 150 to 175 revolutions, giving 50 or more revolutions of the grinding disk. It is also intended that the lateral movement combined with the revolution will distribute the wear uniformly over a large part of the surface of the disk. The flange of

the main frame is arranged to protect the gearing, and a spout at one part carries off surplus sand and water.

The machine was made for the Cambria Iron Company, and is in use by them at Johnstown, Pa. It was built by Riehle Brothers, Philadelphia, Pa.

The Dickerman Twenty-inch Tool Grinder.

The accompanying illustration shows a new 20-inch tool grinder made by the Dickerman Emery Wheel and Machine Company, of Bridgeport, Conn. It is neat and substantial in design, convenient for the operator and confines the water to the right place. The water pan may be quickly drawn through the door in front of the base when it is necessary to clean it, then be placed back in machine and refilled by pouring fresh water into the table, where it will run down into the pan below. The round table in front of the wheel permits the operator to always be at the same convenient distance from the emery wheel, in whatever position he wishes to hold the tool when grinding.

The hood is in one piece except the front, which with the tool rest is adjustable to the wear of the wheel. The emery wheel being encased and with this company's special device inside the hood, water and spray are kept from the emery wheel collars, bearings and floor, and the interior arrangement of the machine is such that no water can get on the floor, inside of the base.

The emery wheel collars are dovetailed and fitted with a device for balancing the wheel. These collars and all other running parts of the machine are turned inside and out, and dust collars are used to keep all water and dirt from



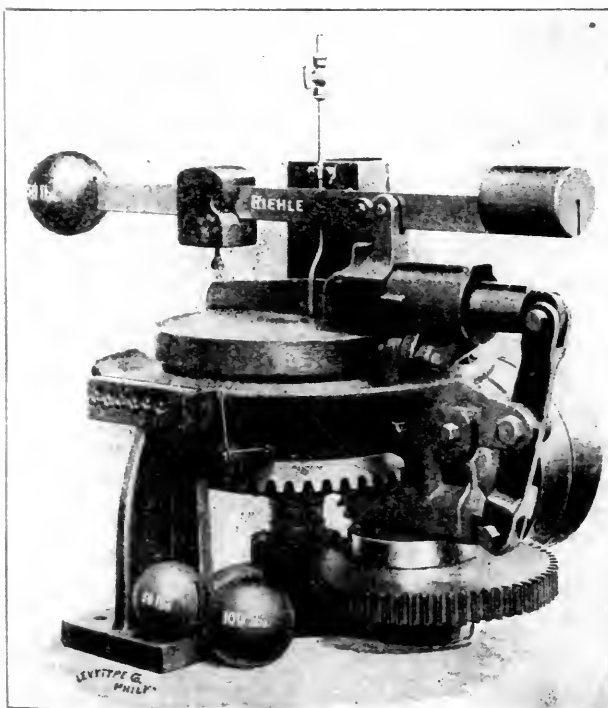
The Dickerman 20-Inch Tool Grinder.

the bearings. This machine being equipped with long self-oiling bearings and a large spindle runs very smoothly. The wheel is 20 inches diameter and 2½ inches or 3 inches face. The diameter of the spindle is 2 inches; the boxes are each 6½ inches long, the spindle pulley 6 inches in diameter and 3½ inches face; the height from the floor to the center of spindle is 36 inches; the foot of base is 20 by 30 inches, and the total floor space occupied is 28 by 35 inches.

Lidgerwood Cableways for the Panama Canal.

Spencer Miller, M. E., engineer of the department of hoisting and conveying machinery of the Lidgerwood Manufacturing Company, New York City, who recently went abroad in the interests of that company, has just closed a contract with the Compagnie Nouvelle Du Canal De Panama at Paris, for seven Lidgerwood cableways, to be used on the Panama Canal. This company is one which has recently been formed to complete the great Panama Canal, and the seven cableways will be used exclusively for earth excavating. They will be equipped with all the latest improvements, including the patent aerial dump, which is such an important feature of these machines, the apparatus throughout being similar in construction to the 29 Lidgerwood cableways used on the Chicago Main Drainage Canal, except that the Panama cableways will have fixed towers and anchorages. The spans will range from 250 to 300 feet.

This order was not placed until after a most careful and extended investigation had been made of the various apparatus available for canal excavating purposes. Engineers were sent by the Compagnie Nouvelle Du Canal De Panama from Paris to examine the Lidgerwood cableways and other excavating machinery in use at Chicago on the canal there building. The result of their investigation was a most flattering report in favor of the Lidgerwood cableways, and the negotiations then begun have resulted in the large order secured by Mr. Miller. This is one of the largest single orders for cableways of any description ever received by any concern in this country from abroad, and points to a world-wide appreciation of the merits of the Lidgerwood cableway.



Riehle Abrasion Testing Machine.

of the casing closes the apparatus. Two gage glasses A B and C D are provided, also a steam coil which takes steam at 5, a steam pipe with an admission valve 1, and faucets 2, 3 and 6.

The operation of the purifier is as follows: Water is poured into the upper pan until it rises to within two inches

The Gatea Iron Works announce the removal of the downtown office at Chicago to 1112 Masonic Temple.

The general offices of Fairbanks, Morse & Co. in Chicago will, on May 1st, be moved to the northeast corner of Monroe and Franklin streets.

The Chicago office of the Schoen Manufacturing Company, of Pittsburgh, has been moved from the fifth floor to Room 1016 of the Monadnock Block.

The Eastman Fruit Dispatch Company has been organized, with \$300,000 capital stock, to manufacture, build, equip, operate, lease and heat refrigerator cars, etc. The general offices are at Jersey City.

The general offices of the United States Metallic Packing Company have been removed to their works, 427 North Thirtieth street, Philadelphia, Pa., and all communications to the company should be addressed to that place.

The United States Wind Engine & Pump Company has sold to the Buffalo & St. Mary's railway two water stations, the tanks for which will be of 60,000 gallons capacity, and will be supported on steel trestles 60 feet high. The wind mills will be each 30 feet in diameter.

The Sterlingworth Supply Company, of 256 Broadway, New York, is erecting a manufacturing plant at Easton, Pa., which it expects to have completed April 1. In the new works there will be ample facilities for the manufacture of the company's various specialties.

The Crane Company, Chicago, has secured the right to manufacture and sell the Mason train signal and Mr. Harry R. Mason, the inventor of the system, has entered the employ of the company. An order has just been obtained to equip 25 engines and 80 cars of the Mexican National Railway with this signal.

The New York Equipment Company, of 80 Broadway, N. Y., is erecting buildings at Dunkirk, Ind., for a large locomotive and car repair shop, and is now in the market for the steam plant and the iron and wood-working machinery requisite for the shop. The plant will be large and complete and the machinery contracts will be large.

The Ontario Car & Truck Company, recently incorporated at Oswego, N. Y., has purchased a site in that place, 125 by 406 feet, and will there erect a large modern plant. The concern will manufacture cars, trucks, ventilators, heaters, seats and brakes. The company possesses a number of patents its capital stock is \$300,000, of which \$100,000 has been paid in.

During one week the Chicago Pneumatic Tool Company recently received orders by mail for two pneumatic hammers from France, three from Russia, four from New Zealand, four from Australia, and one from Austria, besides shipping 10 to London. An additional order of 11 hammers to London received later makes a total of 73 shipped to that city since Dec. 15, 1895.

J. S. Mundy, Newark, N. J., has ready for distribution a pocket edition of his very complete catalogue of hoisting engines, steam boilers, etc. The book is copiously illustrated and contains over 70 pages. It is just the right size to carry in one's pocket without being in the least bulky or in the way. Copies will be forwarded to engineers, contractors and others interested upon application, mentioning this paper.

The Pennsylvania Iron Works Company has recently determined to extend its business by going into the field of hydraulic engineering, and to that end has secured the services of Mr. Ernest W. Naylor, and purchased the rights and privileges of all patents, patterns, etc., owned by him. The company is in a position to enter this new field upon a good basis and any inquiries addressed to it will receive prompt consideration.

The Diamond Machine Company, of Providence, R. I., have just perfected a new and improved machine for grinding cotton mill spindles from the forging. The machine is a combination of their Universal and knife grinders with the necessary attachments for grinding the spindles to the proper taper. The machine gives perfect satisfaction, and although but recently completed orders have been placed by several manufacturers of spindles.

Watson & Stillman have received an order for the building of 15 draw benches for bicycle tube manufacture, each of them with a stroke of 18 feet.

This firm has also for some little time been at work upon a lot of hydraulic machinery for the new American Pulley Works, of Philadelphia, which is to manufacture a new all-sheet steel pulley, in which the hub, spokes and rims are all made of thin sheet steel.

Mr. John T. Wilson, late of Wilson, Walker & Company, of Pittsburgh, Pa., and Mr. J. D. McIlvain, the well-known car builder, now of Pittsburgh, Pa., have interested themselves in the Powell Improved Furnace, with headquarters at 1204-5 Carnegie Building, Pittsburgh, Pa., where they will be glad to meet all their old friends and acquaintances, and new ones, too. The Powell Furnace is adapted to metal working in all the various branches of smelting, puddling or heating.

The American Stoker Company, Dayton, O., have just secured a contract amounting to \$24,000, to supply their stoker system to the two power plants of the Baltimore and Cantonville Construction Company, who will operate an electric railroad between Baltimore and Washington. The power plants are located one at Washington and the other at Baltimore, and are each of 300 horse power, requiring something like 40 of the American Stoker Company's apparatus to operate.—*Iron Age*.

The manufacturers of the Leach sanding apparatus for locomotives announce that they now have a working model, similar to those heretofore furnished air-brake instruction cars for educational purposes, which has been designed ex-

pressly to meet the demand from engineers' and firemen's clubs and lodges. These will not be given away, but will be sold at a nominal price, found necessary for their own protection. Full particulars can be obtained from Henry L. Leach, North Cambridge, Mass.

The Norfolk Cresoating Company, of Norfolk, Va., has completed a fully equipped plant, including three 100-foot cylinders, and all the labor-saving appliances for treating timber of all kinds by oil of coal tar process, with either live or superheated steam. Mr. Edmund Christian, General Manager and Engineer, gives his entire attention to the details of the work. He has had 15 years' experience in treating all kinds of timber and much of the pile work in Norfolk harbor and adjacent waters has been treated under his exclusive supervision.

Robert W. Hunt & Company, 1137 The Rookery, Chicago are inspecting the construction of 150 cars at the works of the Ensign Manufacturing Company, Huntington, W. Va., for the San Francisco & San Joaquin Valley Railway. The same firm will inspect the 600 ore cars to be built by the Pullman Company for the Duluth, Missabe & Northern Railway; 450 ore cars to be built by the Terre Haute Car and Manufacturing Company for the Duluth & Iron Range Railroad, and 400 ore, 20 flat and 4 caboose cars to be built by the Wells & French company for the Lake Superior & Ishpeming Railway Company.

A suit has been entered by the Harris Car Company, of which Mr. Leslie J. Harris is President, against the American Palace Car Company and George A. Denham, Treasurer, in the United States Court of the District of Massachusetts, which involves a patent, covering the exclusive use in sleeping cars of a berth pocket beneath the floor. The Harris patent, on which the suit is based, is well known to railroad men, as a car, "Jeannette," was built in accordance with the same, and was exhibited in all parts of the United States, Canada and Mexico. It is alleged in the bill of complaint that the American Palace Car Company has constructed a car, "Boston," which is a direct infringement of the claims in the Harris patent.

The H. W. Johns Manufacturing Company, which received a gold medal—the highest award of merit—for its exhibit of asbestos manufactures at the Atlanta Exposition, has issued a neat little pamphlet containing illustrations of nine locomotives exhibited at the exposition whose boilers were lagged with the company's asbestos cement felting or fire felt lagging. The fire felt is pure asbestos made in sheets 24 by 36 inches and from $\frac{1}{4}$ to 2 inches thick. The cement felting is composed of asbestos fiber, infusorial earth, and a cementing compound, forming a light porous covering that is applied by mixing with water and putting it on with a trowel, the boiler being warm at the time. Both are excellent boiler laggings.

A great many people, who saw and admired the wonderful electric lighting machines furnished by the Westinghouse Electric and Manufacturing Company to the Columbian Exposition Company for the purpose of illuminating the World's Fair, remarked at the time: "What will be done with these machines when the Fair is over." It may be interesting for these people to learn, that the Westinghouse Company recently furnished four of them to the United Electric Light and Power Company, of New York City, and they are furnishing current for lighting a considerable portion of the metropolis. Several others are installed in the plant of the Brush Electric Light Company at Baltimore, while the rest of them are distributed in several large electric light plants throughout the country.

The Davis & Egan Machine Tool Co., of Cincinnati, formerly the Lodge & Davis Machine Tool Co., controls unlimited capital and the plant which now has 60,000 square feet of floor space will be largely increased. New lines of heavy railroad tools will be added and the business promises to be one of the most extensive of the kind.

The concern manufactures tools for the production of locomotive and stationary engines, steam pumps, electric dynamos and motors, agricultural implements, sewing machines, bicycle machinery, wood-working machinery, mining machinery, etc. It has furnished the United States Government large numbers of machines for the manufacture of cannons, guns, etc., and is well represented in the Navy Yards at Washington, Norfolk, Watervliet, Brooklyn and Mare Island. It cultivates the export trade largely and has made shipments to nearly every civilized country. It has agents who travel in Mexico, South America, Russia, France and Germany. The company operates its own stores in New York, Chicago, Philadelphia, Boston and St. Louis.

The Manufacturers' Advertising Bureau, Benj. R. Western, proprietor, which has been located for a number of years at 111 Liberty street, New York City, will remove about April 15 to more commodious quarters at 126 Liberty street. This concern is widely and favorably known throughout both this country and abroad, and is unique in the business it transacts, which is unlike any other in the world, and consists in taking entire charge of the newspaper work and advertising for manufacturers who desire this very important department of their business conducted with the greatest convenience and profit. The bureau handles almost exclusively concerns who advertise in the trade journals, Mr. Western being a recognized expert in advertising media of this character, and has established a reputation for commercial integrity and scrupulous attention to the interests of its clients, of which it may well feel proud. A large number of the leading machinery concerns in the country now entrust their advertising to the care of this institution. It is because of a growing need for better facilities to transact its business that the change from 111 to 126 will be made.

It is announced that negotiations between the General Electric Company and the Westinghouse Electric & Manufacturing Company resulted last month in an arrangement with respect to a joint use of the patents of the two com-

panies, subject to existing licenses, on terms which are considered mutually advantageous. It has been agreed that after certain exclusions the General Electric Company has contributed 62½ per cent. and the Westinghouse Electric & Manufacturing Company 37½ per cent. in value of the combined patents, and each company is licensed to use the patents of the other company except as to the matters excluded, each paying a royalty for any use of the combined patents in excess of the value of its contribution to the patents. The patents are to be managed by a board of control consisting of five members, two appointed by each company and the fifth selected by the four so appointed. Both companies have acquired during their existence a large number of valuable patents, and numerous suits have been instituted in consequence of the infringement of these patents by one party or the other or by their customers. In the prosecution of these suits large sums of money have been expended, and the general expenses of the companies have in this manner been greatly increased. It is expected that the economies to be effected will be very considerable and that the two companies and their customers will be mutually protected. The especial incentives which led to the arrangement at this time, were the recent decisions in favor of patents of the General Electric Company controlling the overhead system of electric railways, the approaching trials of a number of other important General Electric patents on controllers and details of electric railway apparatus and systems of other electrical devices, and the equally strong position of the Westinghouse Company in regard to power transmission, covered by patents of Nikola Tesla, and in view of its other patents in active litigation, some of which are of little other importance.

New York to California.

A new line of Pullman's latest Compartment Sleeping Cars was inaugurated in January, on the Southern Railway's Piedmont Air Line Limited between New York and New Orleans, connecting with similars cars on the Southern Pacific "Sunset Limited." These cars leave New York on every Tuesday and Saturday at 4:30 p. m., connecting at New Orleans with the Pacific Coast Flyer. These cars are most elegantly furnished and have two drawing-rooms and seven state-rooms. These rooms can be used separate or thrown into a suite or private apartment. The state-rooms are unsurpassable in completeness, having private folding washstand, and all conveniences of most modern drawing-room cars.

Our Directory

OF OFFICIAL CHANGES IN MARCH.

We note the following changes of officers since our last issue. Information relative to such changes is solicited.

Alchison, Topeka & Santa Fe—Mr. John Purcell has been appointed Assistant Master Mechanic at Argentine, Kan.

Baltimore & Ohio—Mr. John K. Cowen, President, and Mr. Oscar G. Murray, First Vice-President, have been appointed Receivers. Robt. B. Campbell, General Manager, has resigned and is succeeded by Mr. Wm. M. Greene. Mr. Harvey Middleton has been appointed General Superintendent of Motive Power, vice Mr. G. B. Hazlehurst, resigned.

Chicago, Burlington & Quincy—Mr. F. A. Chase is appointed Master Mechanic of the Missouri lines, with headquarters in St. Joseph. Mr. I. N. Wilbur is made Division Master Mechanic at Hannibal to succeed Mr. N. J. Paradise, deceased.

Choctaw, Oklahoma & Gulf—Mr. Henry Wood, formerly Acting Manager, has been made General Manager, with headquarters at South McAlester, I. T.

Cincinnati, Hamilton & Dayton—Mr. Chas. G. Waldo, formerly General Superintendent, has been appointed General Manager, vice Mr. Wm. M. Greene, resigned.

Columbus, Hocking Valley & Toledo—Mr. W. A. Mills, heretofore Assistant to the President, has been appointed General Manager, with headquarters at Toledo, O.

Cooperstown & Charlotte—The office of General Manager has been abolished.

Great Northern—Mr. T. E. Adams, Master Mechanic of the Northern Division, has been appointed Superintendent of the Dakota Division, vice Mr. Russell Harding. Mr. T. E. Cramer has been appointed Master Mechanic of the Northern Division, to succeed Mr. Adams.

Indiana, Illinois & Iowa—Peter Maher has been appointed Master Mechanic, vice L. H. Miller, resigned.

Interoceanic of Mexico—Mr. Theodore Klein will, on May 1, take the position of General Manager.

Kansas City, Pittsburgh & Gulf—Mr. E. Dawson has been appointed General Master Mechanic, with headquarters at Pittsburgh, Kan.

Lake Shore & Michigan Southern—Mr. W. H. Canniff, formerly General Superintendent, has been appointed General Manager, Mr. P. S. Blodgett, formerly Assistant General Superintendent has been appointed General Superintendent.

Michoacan & Pacific—The office of the General Superintendent, Mr. L. R. Gordan, removed from Maravatio to Las Trojes.

Monongahela River—Mr. H. G. Bowles, heretofore General Manager, has been appointed General Superintendent, and Mr. J. A. Flickinger is appointed General Manager. Headquarters, Monongahela, W. Va.

Monterey, Mineral & Terminal—Mr. M. C. Grace has resigned as Master Mechanic.

Pittsburg & Western—Mr. Thos. M. King, Second Vice-President of the Baltimore & Ohio, has been appointed receiver by Judge Buffington, of the United States Circuit Court.

Rock Island & Provia—Mr. H. S. Cable has been appointed Vice-President and General Manager.

Southern—Mr. E. L. Chapman has been appointed Assistant Superintendent of Motive Power.

Terminal Road of St. Louis—Mr. William Taussig has resigned the Presidency and is succeeded by Mr. Julius S. Walsh, Mr. E. P. Bryan, General Manager, is made Vice-President in place of Mr. Walsh.

Texas Central—Mr. Henry McHarg has been elected President.

West Shore—Joseph B. Stewart has been appointed Superintendent of the Hudson River Division, Superintendent of the Walkill Valley road, and Superintendent of the Jersey Junction road, in place of William G. Watson, deceased.

AMERICAN ENGINEER CAR-BUILDER AND RAILROAD JOURNAL.

MAY, 1896.

CONTENTS.

ILLUSTRATED ARTICLES:	Page.	EDITORIALS:	Page.
Coaling Station at Washash, Ind., C. C. & St. L. Ry.	70	Revision of Rules and Regulations Affecting Naval Engineers.....	78
Ten-Wheeled Freight Locomotive, N. Y. C. & St. L.	72	Proposed plan for Running Elevated Trains over the New York & Brooklyn Bridge.....	78
Construction and Maintenance of Railway Car Equipment.....	74	Proposed Legislation on the Metric System.....	78
Noiseless Compound Switching Locomotive, N. Y. C. & H. R. R. R.....	78	Locomotive Grates.....	78
Hopper Gondola Car of 60,000 lbs. Capacity, C. R. R. of N. J.....	80	Timber Tests.....	79
Locomotive with Mason-Work Firebox.....	82	MISCELLANEOUS:	
The Most Advantageous Dimensions of Locomotive Stacks and Exhaust Pipes.....	83	Paragraphs.....	69
Milling Machine for Horizontal and Vertical Milling.....	87	Inadequate Yard Facilities.....	73
Hunt Coupling for Transmission Rope.....	87	Experiments on Arches.....	74
Shaper Vise with Striking Plate.....	87	Proceedings of Third Annual Convention of Association of Railroad Air-brake Men.....	79
EDITORIALS:		Notes.....	79
Convention of Air-brake Men's Association.....	78	Programme of St. Louis Convention of American Society of Mechanical Engineers.....	81
Second Class Traffic on English Railroads.....	78	National Convention of Railroad Commissioners.....	81
		Personals.....	81
		Trade Catalogues.....	86
		Manufacturing Notes.....	87
		Our Directory.....	88

The Wheeling & Lake Erie is in the market for from 200 to 500 box cars.

The Chicago & Great Western is said to be in the market for 200 furniture cars.

The Chicago Great Western road will soon give orders for several hundred freight cars.

The Baldwin Locomotive Works have an order for 60 additional locomotives for Russia.

The Lehigh Valley has let a contract to the Michigan-Peninsular Car Company for 1,000 box cars.

The Seaboard Air Line is said to have ordered 12 locomotives from the Pittsburgh Locomotive Works.

The Wells & French Car company has received an order from the Pennsylvania Railroad for 100 hopper-bottom cars.

The New Orleans & Northeastern has given an order for two locomotives to the Richmond Locomotive & Machine Works.

Haskell & Barker, of Michigan City, Ind., are reported to have an order for 150 furniture cars from the Chicago & Northwestern.

The Wisconsin & Michigan Railroad has awarded a contract for 250 box cars to the Missouri Car & Foundry Company, St. Louis.

The Richmond Locomotive and Machine Works has secured an order from Albert Waycott & Co., of St. Louis, for two 55-ton engines.

The Michigan Central road, it is reported, will soon place an order for a large number of freight cars. It is also said to be in the market for about 40 locomotives.

The Delaware, Lackawanna & Western, which recently placed an order with Jackson & Woodin for 1,000 cars, will soon be in the market for an additional 1,000 cars.

The receivers of the Philadelphia & Reading have applied to the United States Court for authority to order 1,000 additional coal cars, 25 refrigerator cars, 250 gondolas and 250 box cars.

The Philadelphia & Reading has placed a contract for 16 coaches with the Pullman Car Company. These cars will be used between Philadelphia and Atlantic City, and will be equipped with Pinch gas and steam heat.

The Grand Rapids & Indiana has placed orders with the Pullman Palace Car Company for three coaches and three combination passenger and baggage cars. The specifications call for the coaches to be 60 ft. long and to seat 70 people.

Messrs. Cramp, the well-known shipbuilders, of Philadelphia, have purchased the patent rights of the Yarrow water-tube boiler, and are urging the United States Government to adopt this steam generator in some of the vessels now under construction.

A premium of £50 is being offered by the Verein Deutscher Ingenieure for the best critical paper, in German, on the development of steam engine construction in all industrial countries during the past 50 years. All papers are to be sent in by Dec. 31, 1898.

Messrs. James Howden & Company, of Glasgow, have in the year just closed entered into contracts for the application of their forced-draught system at home and abroad to no fewer than 105 large steamships having an aggregate of 278,500 I. H. P., among which are vessels equal in size and power to the largest steamships afloat.

The statement has been made that the Pullman Palace Car Company is operating one of the departments of its works at Pullman by means of compressed air. This is not the case, but the company has in contemplation the use of compressed air to a limited extent and by way of experiment. The whole matter is as yet undecided.

President Caldwell, of the Lake Shore, is credited with saying that thus far his road has been a gainer by the construction of suburban electric roads. While these roads may have cut into the local passenger business they have on the other hand proved good feeders, and have brought long-distance passenger traffic to the road from points not on its line.

During the last fiscal year of the government there were exported from the United States a total of 1,934 passenger and freight cars for steam roads, and their value is placed at \$868,378. Of these 103 went over the Canadian border, 267 to Mexico, 123 to Central America, 4 to the West Indies, 316 to Brazil, 113 to Argentina, and 27 to Venezuela, besides several small orders to other South American countries and a very few to Europe.

It is expected that the contracts for the 5,000 cars to be built for the Baltimore & Ohio Railroad will be given out before the first of the month, but at our time of going to press the result has not been announced. The company invited bids on 5,000 cars, 1,800 of which are box, 1,800 solid bottom coal, 400 drop bottom coal and 1,000 drop bottom coal with coke racks. It is rumored that instead of 75 new locomotives the company will purchase 100.

The process of cold riveting has been largely adopted in Europe in the construction of vessels of light scantlings, such as torpedo-boats and torpedo-boat destroyers. In this connection an interesting series of experiments has been recently carried out to determine the pressure necessary for successfully closing up cold rivets. The results are said to have conclusively demonstrated that a pressure of at least 30,000 pounds per square inch of rivet section was required. We would have thought that even higher pressures would be required.

A double-track extension about three-fifths of a mile long is being built by the Liverpool Overhead Electric Railway. For 850 feet the tracks are on a viaduct and then they enter a tunnel 2,400 feet long. The chief feature of interest about the tunnel is that it crosses the tunnel of the Cheshire Lines Railway, there being only three feet between the two. To prevent an additional weight being put on the lower tunnel, a relieving arch is being built immediately over it, upon which will be constructed the side walls of the upper tunnel.

It is stated that the Northern Pacific Railroad contemplates doing more sluicing along the main line in the Cascade Mountains this season than ever before. Twice as many men will be worked and seven bridges located between Easton and Weston will be filled beneath. These bridges run from 50 to 80 feet in height, and are 400 to 500 feet in length. Work will begin in the middle of April and continue as long as water for sluicing is obtainable in the mountains. Gradually all the trestles and small bridges along the entire line are being filled under solid.

Work has been begun upon the electric road between Baltimore and Washington. The grading of the roadbed at both ends of the line is now being carried out. It is proposed to run the cars on this line at a speed of 60 miles an hour, and the tracks are to be built of the heaviest steel rails. The power plant for the road has been contracted for with the Westinghouse Electric Company, there being two power stations, one located about 10 miles from the Baltimore terminal and the other 10 miles from the Washington terminal. The initial power equipment contracted for is equal to about 6,000 horse power.—*Iron Age*.

According to *The Engineer* Messrs. Thornycroft & Company have succeeded in producing a vessel which is not only the fastest vessel in the world, but has attained that position almost at her first effort. It is well known that as a rule fast vessels are worked up by degrees to their maximum speed, small alterations being usually required in the fitting of the valves, amount of grate, trim of boat, area of propeller, etc. But the *Desperate*, torpedo boat destroyer, designed and built by Messrs. J. Thornycroft & Company, ran a preliminary trial, and obtained a mean speed, on four runs on the measured mile, of 31.035 knots, or 35½ statute miles. The speed was taken by Admiralty officials, and is the highest on record.

The Technical Club, recently organized by the members of the engineering professions in Chicago, will establish its headquarters at 238-230 South Clark street. This location is directly opposite the post-office, and near the large office buildings in which so many engineers are located, and is convenient in every respect. The club will occupy three floors of the building, and the rooms will be remodelled to suit its requirements. Library, assembly, lounging and billiard rooms will be provided, also public and private dining-rooms, and rooms for the use of technical societies. The quarters will be heated by steam and lighted by electricity. Mr. Robt. W. Hunt is President of the club, Mr. Chas. E. Billin, secretary, and Mr. H. F. J. Porter, Treasurer.

Some months ago, H. M. S. *Penguin*, Commander A. F. Balfour, R. N., found in the Pacific Ocean deeper water than any yet known in latitude 23.40 S., longitude 175.10 W., but had failed to determine the exact depth owing to breakage of the wire at 4,900 fathoms. Captain Balfour has since been enabled to try again, and has announced three satisfactory soundings of over 5,000 fathoms. The deepest trustworthy sounding heretofore known is 4,655 fathoms, near Japan, obtained by the U. S. S. *Tuscarora* in 1874. The deepest of the *Penguin's* casts is 5,155 fathoms, or 600 fathoms (3,000 feet) deeper; but it is especially remarkable that the three casts now obtained are not in the same hollow, but are separated by areas of considerably less water, the two extreme soundings being 450 miles apart.

The locomotive tires in use on the Great Eastern Railway are made of Bessemer steel, having a tensile strength of 40 tons per square inch, and the following composition: Combined carbon 0.350 per cent.; silicon, 0.083 per cent.; sulphur, 0.064 per cent.; phosphorus, 0.047 per cent.; manganese, 0.605 per cent.; iron—by differences—98.851 per cent. The wear on the tires of some six-wheeled coupled suburban engines in severe service was such that only 2,197 miles was obtained per $\frac{1}{2}$ -inch reduction in thickness, the tires being 4 feet in diameter. Consequently seventeen of these engines were fitted in January, 1892, with special hard steel tires, having a tensile strength of 48 tons to the square inch, and the results obtained up to their first turning were satisfactory. The average mileage was 47,184 for an amount of wear equal to $\frac{1}{2}$ -in. in thickness, or 5,892 miles per $\frac{1}{2}$ -inch reduction.

From a report by the Belgian Vice-Consul at Yokohama, it is learned that railway construction in Japan was interrupted by the war with China, but again great activity is being displayed. A sum of 25,000,000 yen (about \$12,500,000) has been voted for the construction of a double line from Tokyo to Kobe. This line is 376 miles long and passes through the commercial and industrial centers of Japan, Yokohama, Kyoto, Osaka and Kobe. A quarter of a century ago there was not a single mile of railway in Japan. Official figures state that in March, 1895, there were in the country twenty-nine railway companies which had obtained concessions, and 1,549 miles had been opened for traffic. The state railways comprised 550 miles of line completed and 398 miles in course of construction, and for which funds had been voted.

Prof. Weighton, of the Durham College of Science (England), who has made some tests to determine the best angles for the heads of countersunk rivets for ships plates, says: Assuming the specimens were all good representatives of a class, I am inclined to draw the following deductions, viz.: First, for $\frac{1}{2}$ inch plates the countersunk should not be less than 56 degrees, and even a greater angle would seem to be not amiss. Second, for $\frac{1}{4}$ -inch plates the countersunk should not be less than 35 degrees. For other thicknesses the angle of countersunk would be in proportion, and therefore, third, the following would be about the angles proper for the different thicknesses:

$\frac{1}{2}$ -inch plate, 56 degrees angle of countersink.				
$\frac{1}{2}$	"	45	"	"
$\frac{1}{4}$	"	35	"	"
$\frac{1}{8}$	"	26	"	"

Mr. F. W. Webb, Locomotive Superintendent of the London & North Western Railway, has followed closely the development of electric traction for railway work in America, and he has evidently great faith in the feasibility of working main line traffic by this method. Speaking recently at the Crewe Mechanics' Institute he declared that the time might come when trains would run daily from London to Carlisle—300 miles—without stopping. In fact, he said he was prepared to run trains from Euston to Aberdeen without a stop, and guarantee punctuality on arrival. He was prepared also to run trains by electricity, and he predicted that within a few years electric trains would be run to all the great centers at a speed that it was now difficult to realize. Those who have visited the Crewe works will recall the extensive use that has been made of electricity in manufacturing operations, and will be quite prepared to believe that Mr. Webb has good grounds for these somewhat startling declarations.—*Railway World*.

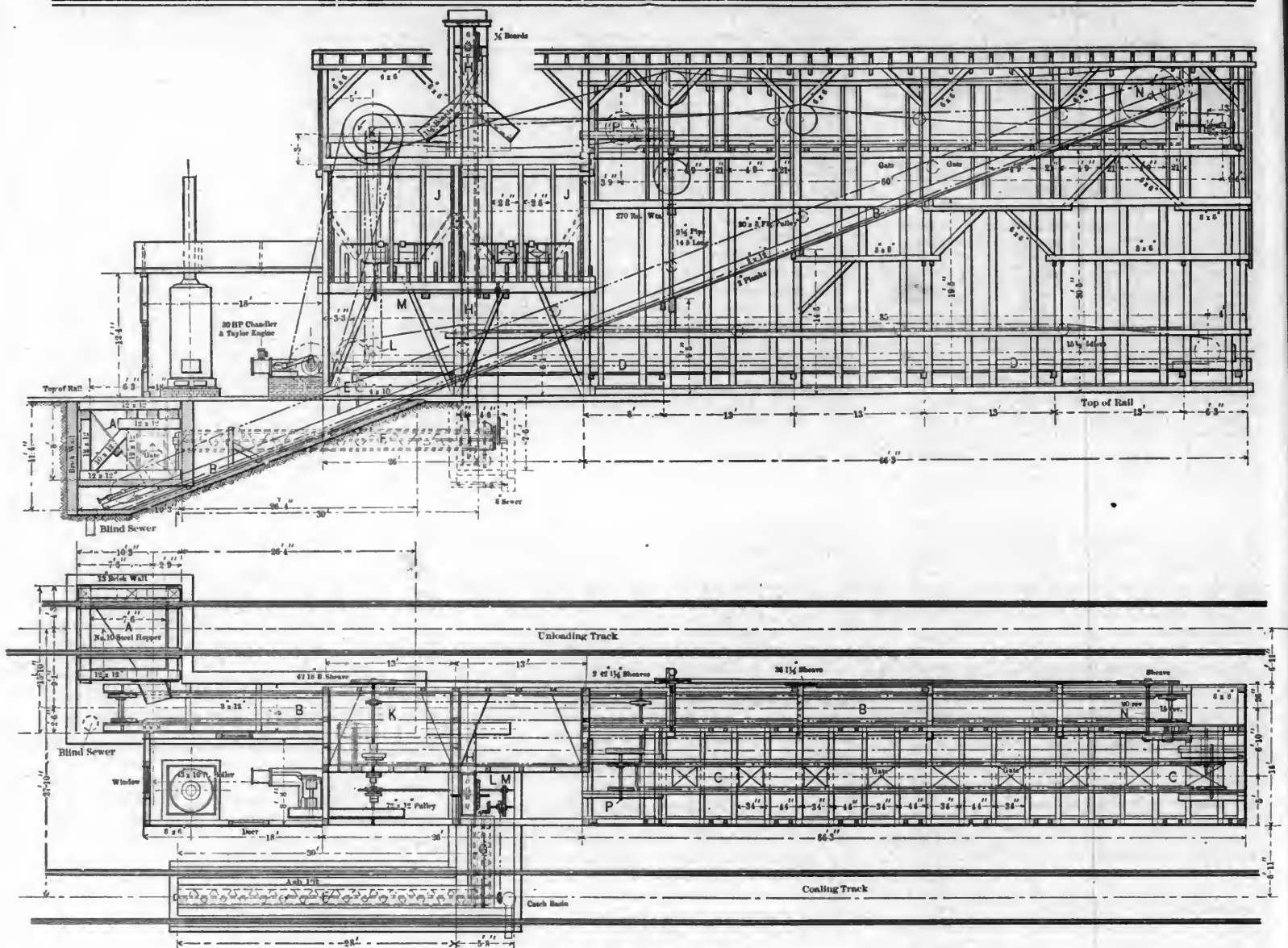


Fig. 5. Elevation and Plan.

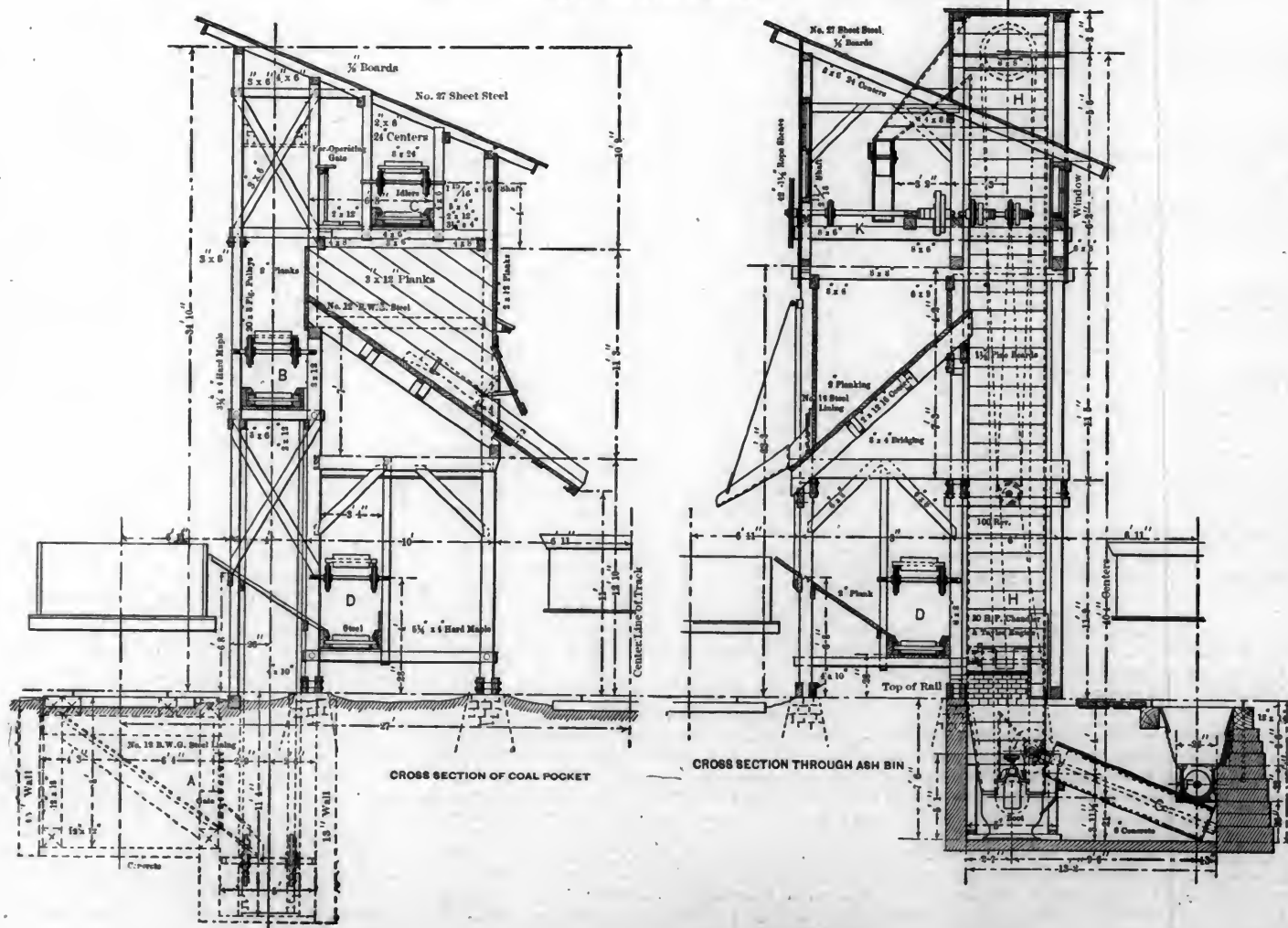


Fig. 6. Fig. 7
WABASH COALING STATION.—CLEVELAND, CINCINNATI CHICAGO AND ST. LOUIS RAILWAY.



Fig. 1. Front View of Coaling Station.



Fig. 2. Rear View of Coaling Station.



Fig. 3. Pocket Conveyor.



Fig. 4. Shoveling Conveyor.

VIEWS OF COALING STATION AT WABASH, IND.-CLEVELAND, CINCINNATI, CHICAGO & ST. LOUIS RY.

Coaling Station at Wabash.—Cleveland, Cincinnati, Chicago & St. Louis Railway.

At the new shops of the Cleveland, Cincinnati, Chicago & St. Louis Railway at Wabash, Ind., the company has installed an interesting locomotive coaling station. It is one of the very few plants constructed in this country for locomotives in which the coal and ashes are both handled by conveyors. Through the kindness of Mr. Wm. Garstang, Superintendent of Motive Power, we have had the privilege of inspecting the plant, and from him we had received the drawings and photographs from which the accompanying illustrations were made.

The chute contains ten coal and two ash pockets, and stands between two tracks, one of which is for the locomotives when being coaled, and the other for cars bringing coal to the chute or carrying away ashes. Of our four half-tone illustrations, Fig. 1 is a view of the side toward the coaling track, showing a locomotive taking coal, while behind the structure are a number of coal cars on the unloading track; though it does not show very clearly, there is an ash pit under the engine, and extending for some distance in front of it; Fig. 2 is a view from the other side, showing the two ash pockets and some of the conveying machinery; Figs. 3 and 4 are interior views showing the pocket and shoveling conveyors respectively. Figs. 5, 6 and 7 are from the working drawings, and show the arrangement of the machinery.

The building is 92 feet 3 inches long and 14 feet wide, with a low extension 18 feet long at one end, in which is placed the engine and boiler. Coal is received in hopper or flat bottom cars on the unloading track. If the cars have hoppers they unload directly into the steel hopper *A* located in the pit between the rails and clearly seen in both views of Fig. 5 and also in Fig. 6. From thence it is delivered through a gate onto the inclined conveyor *B B* which carries it to the top of the building and to the right hand end of it as seen in Fig. 5. There it is dumped onto an inclined chute which delivers the coal to the horizontal conveyor *C*, which passes over the pockets. Over every pocket there is a gate in the trough of the conveyor as seen in the plan view of Fig. 5. Each gate is opened and closed by a rack and pinion operated by the hand wheels seen in Figs. 3 and 7. When a gate is closed the coal is conveyed over it and beyond to the first open gate, through which it drops into the pocket. Battens on the sides of each pocket indicate the height to which they must be filled for two tons, three tons, etc. From the

pockets the coal is, of course, delivered to the locomotive in the usual manner.

Should the coal arrive in flat bottom cars it is then necessary to shovel the coal out of them. Provision has been made for this by providing another horizontal conveyor *D D*, shown in section in Fig. 7. It is also to be seen in Fig. 4, and a glimpse of it is obtained between the posts in Fig. 1. Onto this conveyor the coal falls after it is shoveled out of the car on to the inclined plank shown (Fig. 7). It is by this conveyor taken to the left, in Fig. 4, and delivered through the short chute *E* on to the inclined conveyor *B B*, whence its travels are the same as in the previous case. Of course the coal is transported to the chute in hopper cars where possible, as then there is no shoveling whatever, and no hand labor of any kind.

The manner of handling the ash is equally interesting. An ash pit 28 feet long is located between the rails in front of the engine and boiler house. The bottom of the pit consists of cast-iron gratings made in short sections. Under these there is a screw conveyor running the whole length of the pit and delivering the ash to another screw conveyor placed at right angles to it. This in turn carries the ash into the boot of the elevator *H H*, which takes it to the top of the building and, by means of two aprons, delivers it into the two ash pockets. When the locomotive ash pans are emptied into the pit the plates forming the bottom of the latter are in place, of course, and when the ash accumulates, the conveyor is started up, the plates removed one by one, so as to feed the ash into the conveyor with regularity, and the process goes on, as already described, until the pit is empty. The plates are then put back and the pit is again ready for use.

When the two ash bins are full, a car is run in on the coal unloading track and the ash delivered to it in exactly the same way as an engine takes coal. It will be noticed that the pockets have iron aprons, but the latter are not balanced. Thus the ash is shipped away without any manual labor whatever.

We have described the manner in which the materials are handled, and would now direct attention to the driving mechanism. The small boiler house at the end of the structure contains a 30 horse-power engine and boiler. The boiler is not used at present, however, as steam is taken from the shop boiler. By means of a belt the engine drives the shaft *K*, almost directly above it. From this shaft there is a cable drive to the shaft *N* at the other end of the building, for operating the inclined conveyor. A

chain belt to the shaft *P* drives the horizontal conveyor *C C* over the pockets, and another chain belt from the same shaft *K*, to the shaft *L* drives the shoveling conveyor; still another, with a quarter-turn in it, leading to the shaft *M* drives the ash elevator and screw conveyor. Similar reference letters in the different figures refer to the same objects, and our readers will find no difficulty in tracing out the various driving mechanisms.

The plant was built for the company by the Link Belt Machinery Company, of Chicago, and the details of the conveyors and other apparatus all conform to their well-known and successful designs. The plant has been in operation for some months, and has given perfect satisfaction. Mr. Garstang informs us that as far as its machinery is concerned, the plant could coal nearly 100 engines a day. The coal conveyors will place a carload of coal into the pockets in a very few minutes, and the ash is also handled with dispatch. By means of suitable clutches, the ash and coal conveyor can be operated together or either one alone, the engine having power enough to keep everything moving at once. Three men are required about the plant when it is in full operation, but it does its work so rapidly that these men do not give their entire time to it, but are assigned other duties. The cost of the plant was hardly any more than would have had to be expended for an ordinary coaling station with a trestle, an ash pit, depressed tracks, etc. This station also occupies less space than any stations of the same capacity having one track on a trestle and another depressed, and this is an important consideration in many cases.

The plant is an excellent illustration of what can be done in reducing the cost of handling coal and ash with a comparatively small outlay, and its compactness and large capacity, the reduction of labor and the general excellence of the design, should induce railroads to look upon such machinery with greater favor. It is pretty safe to say that the item of labor in coaling locomotives and disposing of their ash is much greater than is generally believed, and that the subject does not receive the attention it deserves. At large terminals, or points where many engines are coaled daily, conveyors have been introduced, but we think that few, if any, conveyors have been installed at coaling stations of moderate size, excepting the Wabash plant. But the small stations are the more numerous and should receive attention. A large economy over present practice can be effected, and the plant we have described is an excellent example of how it can be done.

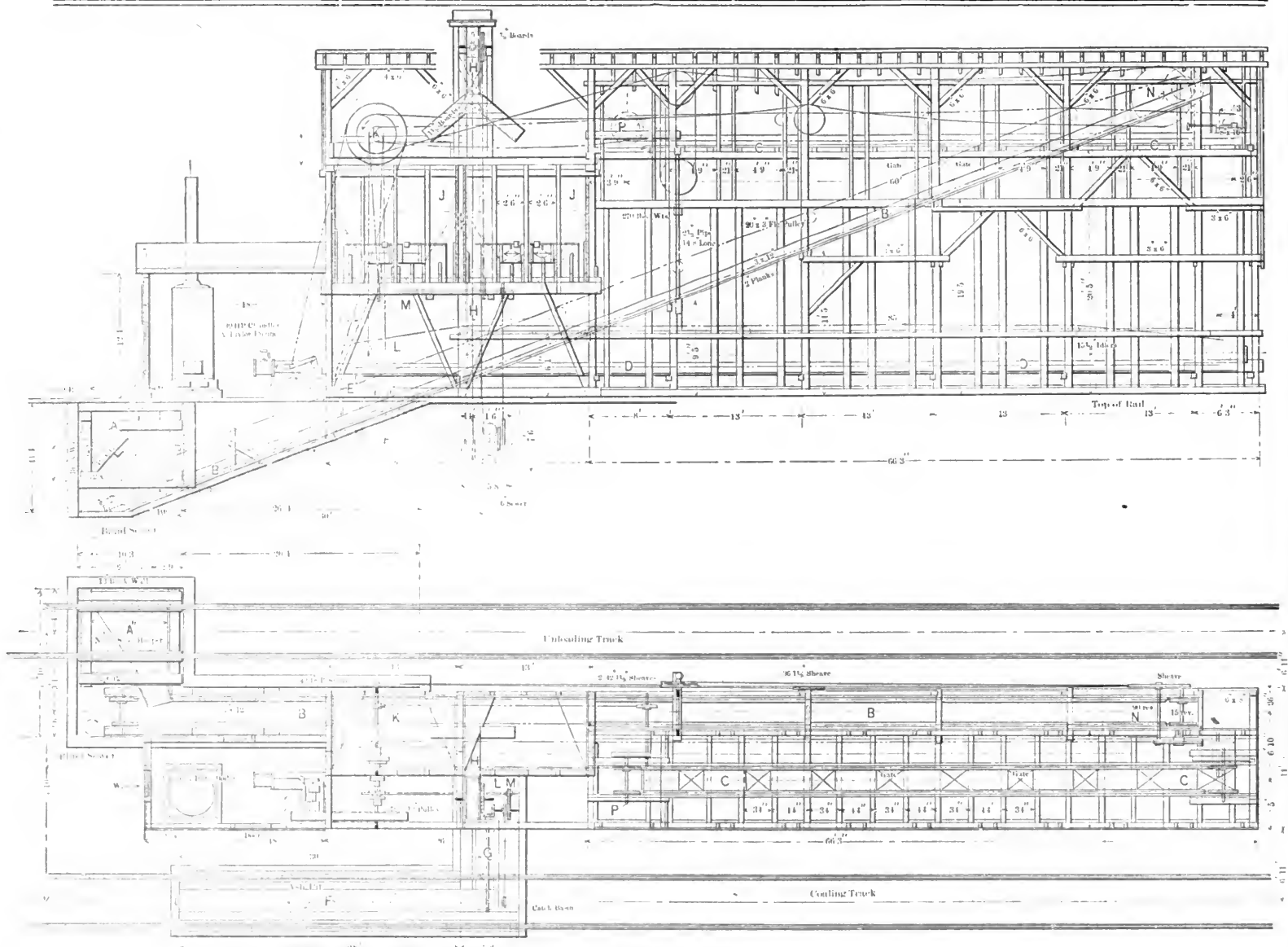


Fig. 5. Elevation and Plan.

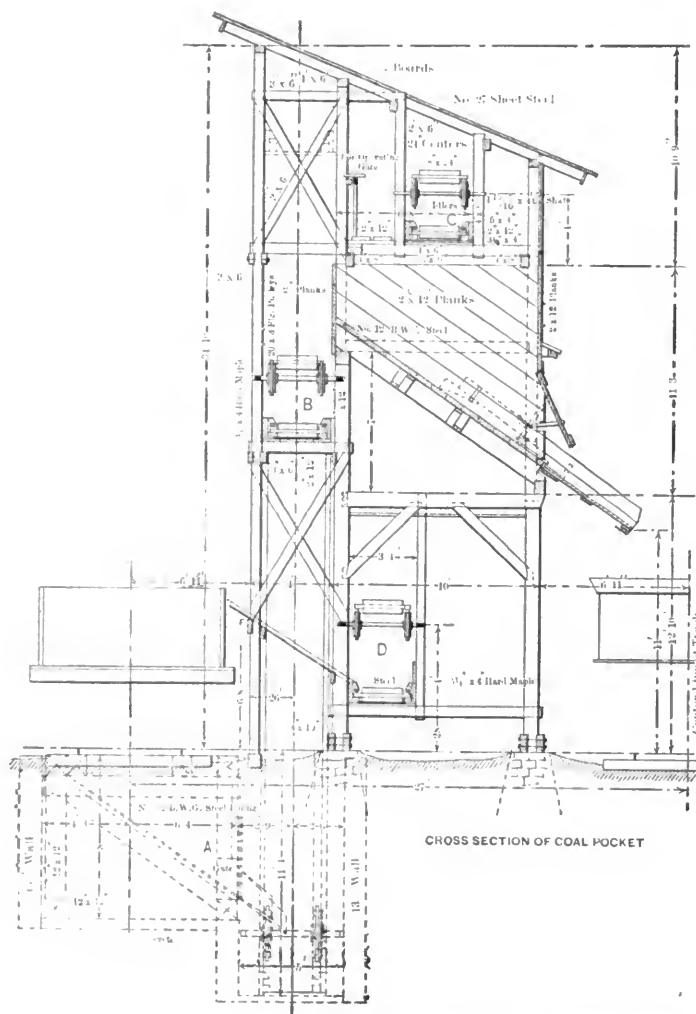


Fig. 6. CROSS SECTION OF COAL POCKET.

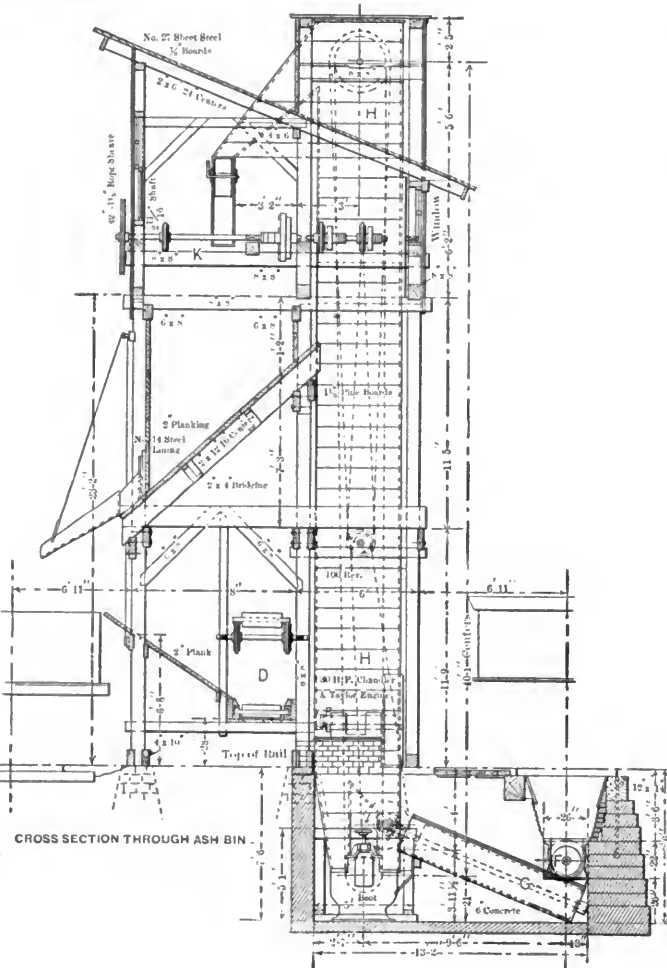


Fig. 7.

Fig. 7. CROSS SECTION THROUGH ASH BIN.

WABASH COALING STATION.-CLEVELAND, CINCINNATI CHICAGO AND ST. LOUIS RAILWAY.

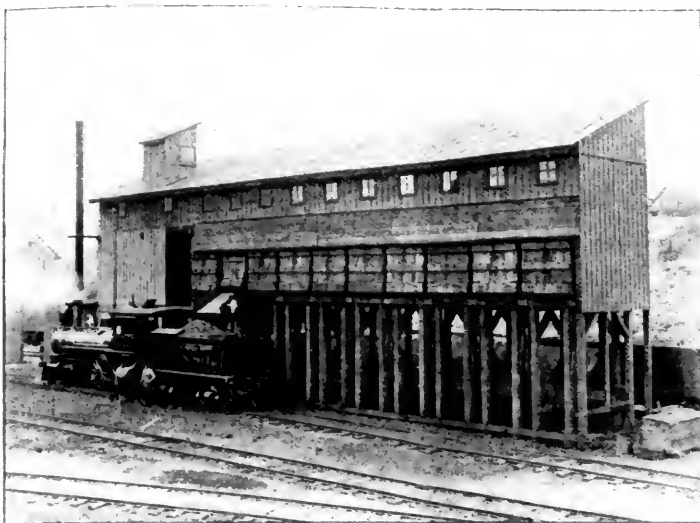


Fig. 1. Front View of Coaling Station.

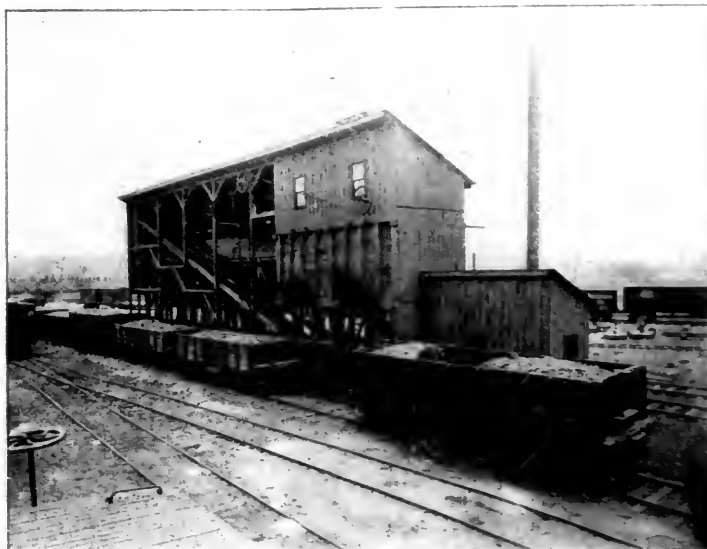


Fig. 2. Rear View of Coaling Station.



Fig. 3. Pocket Conveyor.



Fig. 4. Shoveling Conveyor.

VIEWS OF COALING STATION AT WABASH, IND.—CLEVELAND, CINCINNATI, CHICAGO & ST. LOUIS RY.

Coaling Station at Wabash.—Cleveland, Cincinnati, Chicago & St. Louis Railway.

At the new shops of the Cleveland, Cincinnati, Chicago & St. Louis Railway at Wabash, Ind., the company has installed an interesting and complete coaling station. It is one of the very few plants of this kind in this country for locomotives in which the coal and ashes are both handled by conveyors. Through the kindness of Mr. Wm. Garstang, Superintendent of Motive Power, we have had the privilege of making the plant and from him we had received the drawings and photographs from which the accompanying illustrations were made.

The chute contains ten coal and two ash pockets, and stands between two tracks, one of which is for the locomotives when being coaled, and the other for cars bringing coal to the chute on carrying away ashes. Of our four half-tone illustrations, Fig. 1 is a view of the side toward the coaling track, showing a locomotive taking coal, while behind the structure are a number of coal cars on the unloading track; though it does not show very clearly, there is an ash pit under the engine, and extending for some distance in front of it; Fig. 2 is a view from the other side, showing the two ash pockets and some of the conveying machinery; Figs. 3 and 4 are interior views showing the pocket and shoveling conveyors respectively. Figs. 5, 6 and 7 are from the working drawings, and show the arrangement of the machinery.

The building is 92 feet 3 inches long and 14 feet wide, with a low extension 18 feet long at one end, in which is placed the engine and boiler. Coal is received in hopper or flat bottom cars on the unloading track. If the cars have hoppers they unload directly into the steel hopper *A* located in the pit between the rails and clearly seen in both views of Fig. 5 and also in Fig. 6. From thence it is delivered through a gate onto the inclined conveyor *B B* which carries it to the top of the building and to the right hand end of it as seen in Fig. 5. There it is dumped onto an inclined chute which delivers the coal to the horizontal conveyor *C*, which passes over the pockets. Over every pocket there is a gate in the trough of the conveyor as seen in the plan view of Fig. 5. Each gate is opened and closed by a rack and pinion operated by the hand wheels seen in Figs. 3 and 7. When a gate is closed the coal is conveyed over it and beyond to the first open gate, through which it drops into the pocket. Battens on the sides of each pocket indicate the height to which they must be filled for two tons, three tons, etc. From the

pockets the coal is, of course, delivered to the locomotive in the usual manner.

Should the coal arrive in flat bottom cars it is then necessary to shovel the coal out of them. Provision has been made for this purpose by another horizontal conveyor *D D*, shown in section in Fig. 7. It is also to be seen in Fig. 1, and a large pile of it is shown between the posts in Fig. 1. On to this conveyor the coal falls, after it is shovelled out of the car on to the inclined platform shown in Fig. 7. It is by this conveyor run into the bin in Fig. 1, and delivered through the short chute *E* on to the inclined conveyor *B B*, where it travels the same as in the previous case. Of course the coal is transported to the chute in hopper cars where possible, as then there is no shoveling whatever, and no hand labor of any kind.

The manner of handling the ash is equally interesting. An ash pit 28 feet long is located between the rails in front of the engine and boiler house. The bottom of the pit consists of cast-iron gratings made in short sections. Under these there is a screw conveyor running the whole length of the pit and delivering the ash to another screw conveyor placed at right angles to it. This in turn carries the ash into the boot of the elevator *H H*, which takes it to the top of the building and, by means of two aprons, delivers it into the two ash pockets. When the locomotive ash pans are emptied into the pit the plates forming the bottom of the latter are in place, of course, and when the ash accumulates, the conveyor is started up, the plates removed one by one, so as to feed the ash into the conveyor with regularity, and the process goes on, as already described, until the pit is empty. The plates are then put back and the pit is again ready for use.

When the two ash bins are full, a car is run in on the coal unloading track and the ash delivered to it in exactly the same way as an engine takes coal. It will be noticed that the pockets have iron aprons, but the latter are not balanced. Thus the ash is shipped away without any manual labor whatever.

We have described the manner in which the materials are handled, and would now direct attention to the driving mechanism. The small boiler house at the end of the structure contains a 30 horse-power engine and boiler. The boiler is not used at present, however, as steam is taken from the shop boiler. By means of a belt the engine drives the shaft *K*, almost directly above it. From this shaft there is a cable drive to the shaft *N* at the other end of the building, for operating the inclined conveyor. A

chain belt to the shaft *P* drives the horizontal conveyor *C C* over the pockets, and another chain belt from the same shaft *K* to the shaft *L* drives the shoveling conveyor; still another, with a gear return in it, leading to the shaft *M*, drives the ash conveyor and screw conveyor. Similar to these are the shafts *O* and *Q*, which refer to the same objects, and their relations will not be difficult in tracing out the various connections.

The plant was built for the company by the Link Belt Manufacturing Company, of Chicago, Ill., and the design of the conveyors and other apparatus is due to their well-known and successful engineers. The plant has been in operation for some months, and has given perfect satisfaction. Mr. Garstang informs us that as far as its machinery is concerned, the plant could easily run engines a day. The coal conveyors will place a car load of coal into the pockets in a very few minutes, and the ash is also handled with dispatch. By means of suitable clutches, the ash and coal conveyors can be operated together or either one alone, the engine having power enough to keep everything moving at once. Three men are required about the plant when it is in full operation, but it does its work so rapidly that these men do not give their entire time to it, but are assigned other duties. The cost of the plant was hardly any more than would have had to be expended for an ordinary coaling station with a trestle, an ash pit, depressed tracks, etc. This station also occupies less space than any stations of the same capacity having one track on a trestle and another depressed, and this is an important consideration in many cases.

The plant is an excellent illustration of what can be done in reducing the cost of handling coal and ash with a comparatively small outlay, and its compactness and large capacity, the reduction of labor and the general excellence of the design, should induce railroads to look upon such machinery with greater favor. It is pretty safe to say that the item of labor in coaling locomotives and disposing of their ash is much greater than is generally believed, and that the subject does not receive the attention it deserves. At large terminals, or points where many engines are coaled daily, conveyors have been introduced, but we think that few, if any, conveyors have been installed at coaling stations of moderate size, excepting the Wabash plant. But the small stations are the more numerous and should receive attention. A large economy over present practice can be effected, and the plant we have described is an excellent example of how it can be done.

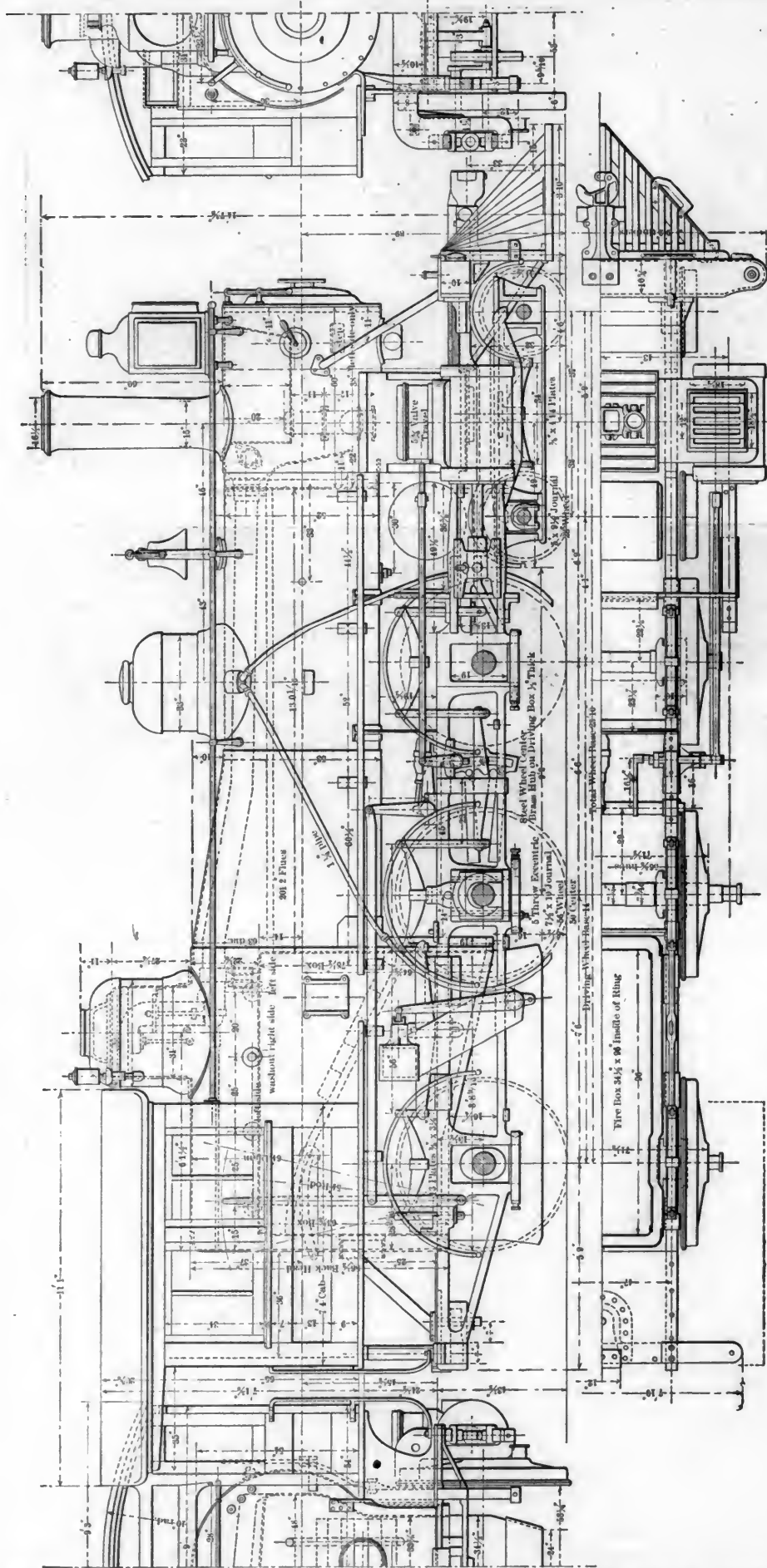


Fig. 1. Ten-Wheeled Freight Locomotive—New York, Chicago & St. Louis Ry.

Ten-Wheeled Locomotive—New York, Chicago & St. Louis Railway.

The New York, Chicago & St. Louis Railway has recently put in service ten new 10-wheeled freight engines, five of which were built by Brooks Locomotive Works, and the remaining five by the Schenectady Works. Through the courtesy of Mr. John McKenzie, Superintendent of Motive Power, we publish the accompanying illustrations of them.

The engine has 18 by 24 cylinders, which in some sections of the country would not be considered large, but as the divisions of the road on which these engines operate have no grades heavier than 40 feet to the mile, and only a few as steep as that, this size of cylinder is found large

enough to haul a train of 43 cars in all ordinary weather and one of the engines is stated to have handled a train of over 1,200 tons on this grade.

The engines have rigid center trucks, and the plain tires are placed on the forward pair of drivers. The links are back of the forward axle and neither long eccentric rods nor intermediate rockers are employed. A respectable radius of link, 45 inches, is obtained and the whole link motion is as free of objectionable features as in an ordinary eight-wheeled engine.

The boiler, shown in Fig. 2, is of the wagon top style and 52 inches in diameter at the first course. The crown is stayed with crown bars, and the firebox is between the frames and over the rear driving axle. The boiler is of substantial construction throughout, and some of its details are un-

common. The longitudinal seams are butted with inside and outside welts. The circumferential seams are double riveted. In the construction of the firebox, the flange of the tubesheet is made of the usual length at the top and for a short distance down the side, but as the sheet narrows the flange deepens until it measures $9\frac{1}{4}$ inches. This does not cause any waste of metal, and it carries the seam away from the corner of the firebox ring, which is believed to be an advantage. It is expected to prevent cracking of the sheets at the seams. The ring has drop corners and is machined inside and out at the corners. It is "set in" one inch opposite the driving boxes, but its full width of 3 inches is maintained. The water space of 4 inches at front is straight, but the back and side spaces enlarge toward the top, those at the sides becoming $7\frac{1}{4}$ inches. This is believed to be the best possible preventive of broken staybolts. The crown sheet is not arched, but is given a flat slope on each side of the center.

The crown is supported by bars 5 inches by $\frac{1}{2}$ inch, and from each of these there are two slings stays to the shell. Their upper ends are attached to long tee irons made out of two sheets bent into the form of angles, and extending from near the back head to the dome, with a short section ahead of the dome also. All stays, whether they go to the shell or the dome, have a pin joint in them just above the crown bar. The back head and front tubesheet are supported by gusset stays. The wide water spaces at the sides of the firebox have necessitated two additional stays on each side below the crown, as shown.

The thimbles for the crown-bar bolts are of cast steel, and are not of the conical form so usual in American practice. From the detail shown in Fig. 3 it will be seen that they are cylindrical, one-fourth of an inch thick, and have a rectangular flange at the top end, on which the crown bars have contact. A small projection fits between the bars and prevents the thimble from turning.

The dome is secured to the shell by a solid ring $\frac{1}{2}$ inch thick and flanged upward for the domesheet. It measures $6\frac{1}{2}$ inches by $4\frac{1}{2}$ inches by $\frac{1}{2}$ inches in section. The firebrick in the firebox is supported upon $2\frac{1}{2}$ -inch water tubes. The heating surface of the arch tubes is 10 square feet, the

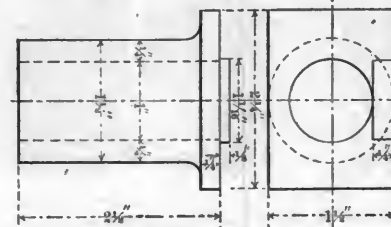


Fig. 3.—Crown Bolt Thimble.

firebox is 145 square feet, and tubes 1,360 square feet, giving a total of 1,515 square feet, while the grate area is 22.4 square feet.

In looking over the elevations in Fig. 1 the reader will notice that most of the details conform to common practice. One departure might be mentioned. The pedestals in the main frames for the rear and front drivers are perfectly straight and two shoes are used instead of the one shoe and one wedge per pedestal, which has been the almost universal practice for years. This arrangement by which a ready adjustment for wear at the driving boxes is deliberately dispensed with, is meeting with favor among those whose observation has led them to conclude that more trouble is caused by unwise adjustment than can arise from the lack of any take-up. The main pedestal has the old form of shoe and wedge, evidently provided for fear of pounding at the main journals.

It is customary to close the bottom of the pedestal with a thimble and bolt or a cap, but in these engines their place is taken by a stirrup or strap, which passes outside and around the lower ends of the jaws and is tightened by a large screw bearing on a gib notched into the outside of the jaw to keep it in place. A similar gib at the other end notched into the frame in the same way gives an additional safeguard against the strap slipping out of place. This arrangement is very neat, and has the advantage over the thimble and bolt of not cutting into the frame, while at the same time there is no limit to the strength of the strap; it should be cheaper than a well-fitted cap, and it appears to be easier to remove and put on than either cap or thimble and bolt.

The crosshead is of cast steel and symmetrical with relation to the piston rod. It is a form that many are adopting in place of the Laird type, which by its unsymmetrical form is believed to be the cause of many broken piston rods.

The link motion shown in Figs. 4 and 5 is worthy of attention. All bearings are very large. The link itself is 3 inches wide, and the block is 7 inches long. These substantial proportions are carried into all the details. But perhaps the most interesting feature is the means provided for oiling the various surfaces. Ordinarily most of the surfaces of the link motion are only supplied with oil through a small oil hole each time the engineer goes around with his long snouted oil can, but these engines are expected to haul trains long distances without making stops long enough to permit oiling, and the link motion has been provided with little oil reservoirs in connection with every surface requiring oil. These reservoirs

are all like an rod pin hole 1 1/2 tapped hole 1/2 inch and passing for with w cient q In the plied v lubricat one and whole a lubricat that th through McKenz excellen The e grooves The eco ing surf These months agement sions: Cylinder Steam p Exhaust Valve tr Driving Driving Total w Boiler at Boiler, d Number Size of Firebox Grate ar Heating Heating Heating Heating Steam p Weight Total w

The e grooves The eco ing surf

These months agement sions:

Cylinder Steam p Exhaust Valve tr Driving Driving Total w Boiler at Boiler, d Number Size of Firebox Grate ar Heating Heating Heating Heating Steam p Weight Total w

The e and ro treated facing The sh boxes. is used brakes crum makin

In a sented Michig Railro ments with t

With ing th into ex the fir in the pany a done t the w so as sible. move cut, t must

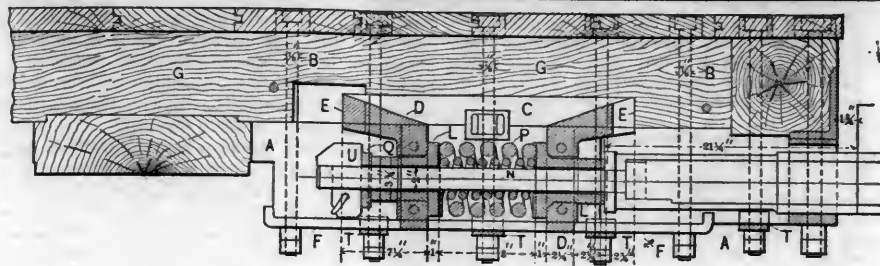


Fig. 24.

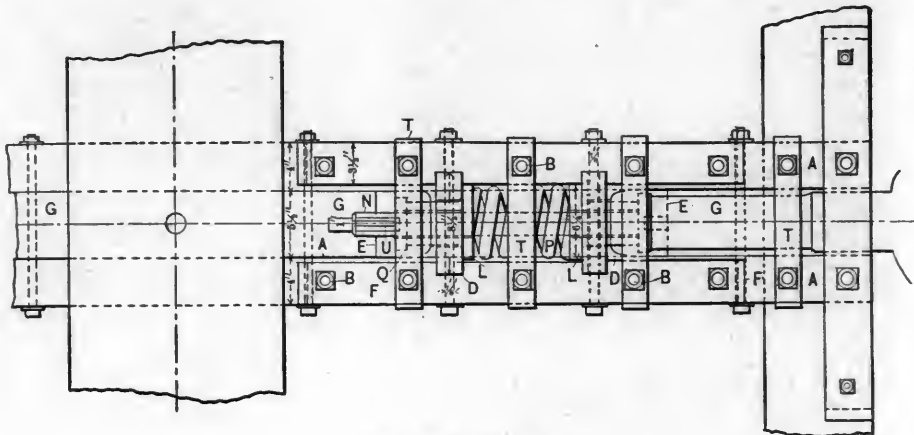


Fig. 25. Inverted Plan.

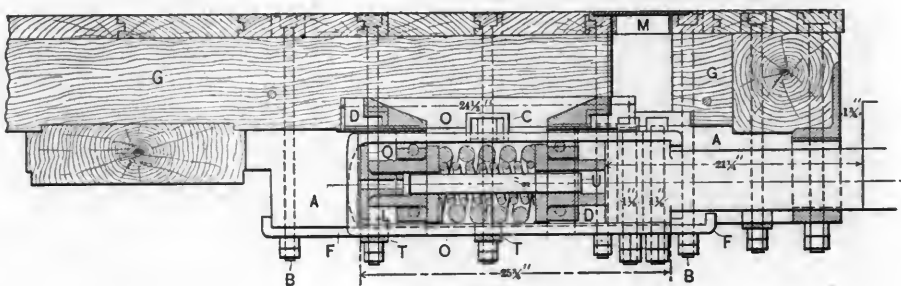


Fig. 26.

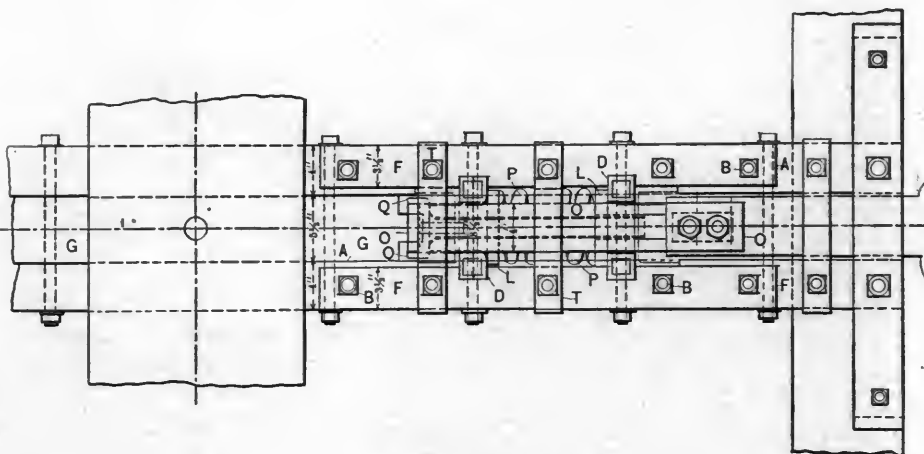


Fig. 27. Inverted Plan.

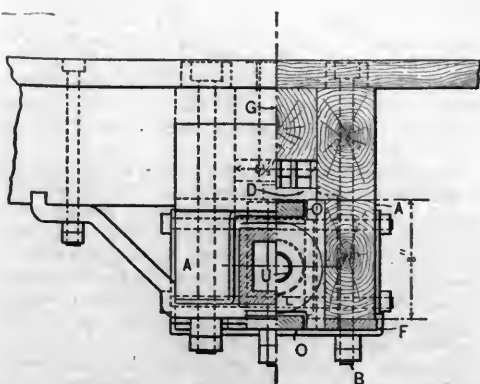
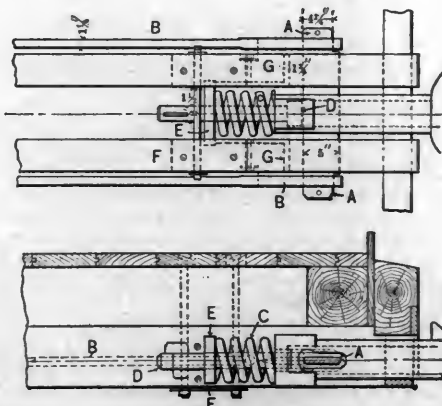


Fig. 28.



Figs. 29 and 30.

means of a casting, *MM*, let into and secured to the floor by screws.

Another variety of this draft gear, which is used to quite some extent, has two straps of $\frac{1}{2}$ by 4-inch wrought iron, riveted on top and bottom of the drawbar by $\frac{1}{4}$ -inch rivets, and extending back through the cheek pieces and fastened together behind the rear one by means of a $\frac{1}{4}$ -inch pin; this pin has a lug on one side of its top end, and the holes in the strap through which it passes are made of such shape that this lug will pass through in one position, but will rest on the top strap when given a quarter turn; the pin is locked in place by a key through its lower end, passing between lugs on a distance piece placed between the two straps, which also has a cylindrical lug on its front end which engages the back follower thimble; a piece of pipe or boiler tube is inserted in the two thimbles and the draft spring, and serves to hold these in place.

CONTINUOUS DRAFT GEARS.

In the different draft gears, as far as described, the strains are transmitted from the drawbar to the sills at each end of the car, and from one end to the other by the sills alone. There is a tendency in late years among car-builders to relieve the sills of some of the strains, both pulling and buffing; for the pulling strains this is done by bolting to each draft timber a 1-inch rod with a flat gibbed end, the rod passing back to and through the adjacent cross-tie timber, and having a nut on its end resting on a large washer. The cross-tie timbers are likewise connected by one or two rods passing between and through them, with nuts on the outside of each, making practically a continuous connection between the draft timbers at the two ends of the car. To take the buffing strains timbers are placed under the center sills, between the rear ends of the draft timbers and the adjacent cross-tie timbers, and others between the two cross-ties, making practically a continuous timber from end to end. These subsills are bolted to the sills and are usually also keyed to them by cast-iron blocks. When wooden bolsters are used the draft timbers usually end at the bolster, and the subsills are fitted between the bolsters and cross-ties; with iron plate bolsters the draft timbers are sometimes carried back through them for a foot or two, being shouldered against the bolster. In either case, the short draft timbers can be removed if necessary without disturbing the subsills.

Instead of attaching the rods mentioned to the draft timbers, they are sometimes connected directly to the drawbars, forming the so-called continuous draft rigging. There are several kinds of this in use, the earliest introduced consisting of a long rod or spindle which passes through below the center sills and is connected to each drawbar by means of a key. The draft spring is placed directly against the end of the drawbar and at the other end bears against a wooden block fitted between the draft timbers, no follower-plates being used. When a pulling strain is applied to a car with this gear, the spring at the end opposite to the one at which it is applied is compressed. Under a buffing strain, the spring at the end where it is applied, comes into action, so that there is always a thrust against one of the spring blocks. The slot in the drawbar or in the spindle must be made long enough to allow the spring to be compressed when subjected to buffing strains, without moving a draft rod. This gear is not much used at present on cars of large capacity, although a modification of it was lately introduced in which the rod was made in two pieces, connected together at the center by means of a right and left turn-buckle, the connection to the drawbar being made by means of heads on the rods instead of the key.

These draft rods pass through the body bolster at the center, and therefore come in the way of the center pin, which has to be cut off and is usually made with a head resting in a socket on the top side of the body center plate, which must be removed to renew the pin. To overcome this objection the draft gear shown in Figs. 29 and 30 has been devised. The rear end of the drawbar is provided with a horizontal slot, through which a key *AA* of 1 by 5 inch wrought iron passes; this key is long enough to also pass through the two draft-timbers and project about 3 inches. Two draft rods *BB* are employed, which are made of $\frac{1}{2}$ inch round iron and terminate on each end in a loop about 10 inches long, which is passed over the projecting ends of the draft key and secured in place by a cotter through the key on the outside of the loop. The cross-tie timbers and wooden bolsters have to be cut out large enough to let the loop on end of draft rod pass through. The draft key is generally made $\frac{1}{4}$ inch narrower at the ends where the draft rods bear, so that they may be reversed to take up any lost motion which is liable to develop. The draft spring *CC* is secured to the drawbar by means of the tailpin *DD*, which passes through the stationary follower plate *EE*, which is mortised into the draft-timbers and is held in place by the follower plate supports *FF*. Bolts through the draft timbers, back of the follower plate, tie them together. The slots in the draft-timbers through which the draft key passes are made about $\frac{1}{4}$ inches longer than the width of the key to allow for the compression of the spring, and a piece of iron, *GG* bent in the shape of an angle, is fastened in this slot for the key to strike against. For heavy cars, two springs are sometimes used with this draft gear, each one bearing on a stationary follower plate and one tailpin passing through both springs.

(To be continued.)

Third Annual Convention of the Association of Railroad Air-Brake Men.

The third annual convention of the Association of Railroad Air-Brake Men met at the American House, Boston, Mass., at 9 a. m., April 14, President Hutchins in the chair. Prof. George F. Swain, of the Massachusetts Institute of Technology and member of the State Railroad Commission, made an excellent opening address, in which he gave some figures illustrating the comparative safety of railroad travel. Much of this safely he attributed to the efficiency of the air-brake, and increased speeds with safety as great as at present he held can only be obtained by greater intelligence in the use of the brake, better maintenance, and a more general equipment of cars with it. Hence the importance of the association's work. He also believed that it was actual economy for the railroads to spend money for freight brakes, because of the economies in train operation resulting therefrom, the safety and speed, and even the decreased headroom required for overhead bridges when men no longer have to walk on top of the cars of a train. In closing his remarks he welcomed the association to the city and expressed the hope that the convention would be a most profitable one.

President Hutchins replied for the association and then proceeded to read his address. He spoke of the rapid growth of the association to a membership of over 200 in three years, its good standing financially, the value of its work being recognized by the purchase of the reports of its proceedings to a phenomenal extent, and to the general interest taken in its work. He touched on high speeds and the high-speed brake, slack adjusters and other improvements, but he emphasized the fact that the great work of the association was to suggest and carry out in practice betterments in the instruction of the men who handle the air-brakes and to attain a higher standard in the maintenance of the brakes. To do this they needed the support of superior officials, instruction cars and test yards. Air-brake cars should be ordered to the head of the train and used regularly. Occasionally we hear of a road ordering its men not to use the air on freight trains. Instead of being an exhibition of old fogeyism it may be a punishment for rough handling of trains. In such cases the order might eventually do good as the men will use the brakes even if they have to steal their use and at such times they will learn to handle them with care to avoid detection. In closing, he complimented the association on the promptness with which it handled its business last year and hoped it would do as well in this convention.

The Secretary's and Treasurer's reports showed the membership to be 216, and the funds in the treasury, March 31, to be \$922.35. Since that date \$118 had been received, making over \$1,000 in the treasury. Practically the entire edition of last year's proceedings, 2,000 copies, had been sold except the small number distributed to the members.

Several communications were then read; one from the New England Railroad Club, invited the members to attend its meeting held on the evening of the 14th; the New York, New Haven & Hartford Railroad invited the association to make an excursion over its line to Plymouth; the Fitchburg Railroad invited them to visit the interlocking plant at its Boston terminals, and Sherburne & Company invited them to visit its offices and see a sanding apparatus worked in conjunction with the air-brake. These invitations were accepted, and the various trips taken at hours that did not interfere with the sessions of the convention.

The first report of committees to be read was that on "Piston Travel." This report is a voluminous but an admirable one. It discusses the loss of air in brake applications when the piston travels are uniformly long, the evils of various lengths of travel in the same train resulting in solid wheels, etc.; lost travel or that part of the travel resulting from slack in truck bolsters, center plates, boxes, deflecting brakebeams, etc.; and records the results of tests made on the St. Paul & Duluth Railroad, with cylinders having indicators attached. Rules are suggested for air-brake tests of trains arriving at division terminals. The report closes with the following recommendations:

1st. That yard tests be made from a 90 pounds train pipe pressure and a full service application, and piston travel adjustments, based on this, be made $5\frac{1}{2}$ inches for freight and 7 inches for passenger.

2d. That road tests be made from not less than 50 pounds pressure for freight and 60 pounds for passenger, and that readjustments be made to between 5 and 6 inches on freight and 6 and 7 inches on passenger where found less than $4\frac{1}{2}$ inches on freight and $5\frac{1}{2}$ inches on passenger, or where over 8 inches on either.

3d. That brake cylinders of such size be employed as recommended in Westinghouse Air-Brake Company's circular of Dec. 1, 1895, that total leverage necessary to employ may not be excessive.

4th. That brake rigging (including beams) of sufficient strength be employed as will reduce deflection to a minimum.

5th. That lost travel due to truck construction and wear be as much reduced as possible.

The discussion was brief and was chiefly on the recommendation to use 90 pounds pressure for a yard test. Some claimed that it could not be obtained in many yards because of low steam pressure, and others doubted the wisdom of it, but the majority were in favor of it.

The next report to be considered was that on "Slack Adjusters." The value of a good slack adjuster was admitted but the committee had not found any device that could be pronounced perfect. It defined what an adjuster should do to fill the bill, the most desirable location for it, and the effect of the change in angularity of the brake levers as the slack is taken up. The committee conducted tests on this point to satisfy the doubting Thomases and found the brake power was practically constant for large variations in the angularity of the levers.

The discussion brought out nothing new but served to emphasize the need of practical and successful devices of this kind.

The committee appointed to formulate a series of questions and answers on the air-brake next reported. Its report involved an immense amount of labor, but on account

of its length—their being nearly 600 questions with their answers—it could not be discussed to advantage. It was disposed of by being ordered printed, and the committee requested to meet after the session to listen to any arguments which members might present to them on any part of the report.

The second day's business of the convention began with the reading of the report on "Water-Raising Systems on Sleeping Cars." The report describes the four different methods used up to date, and illustrates them. If the committee had done nothing else, its work would have been important, as information along this line has not been complete by any means. It recommends a method of testing, and closes with the following recommendations:

1st. That all water-raising systems using the first and second methods be changed to the third method.

2d. That a duplex air gate be placed in the wash-room of all sleeping cars using the water-raising system, and that the red hand be connected to the air pressure tank, and the black hand to the water tanks.

3d. That the reducing valve be regulated to permit but 20 pounds of air pressure on the water tanks.

4th. That the air pressure governor valve and the pressure reducing valve be given a more accessible location, and that "Governor Valve" and "Reducing Valve" be plainly stenciled on the door of the box containing them.

5th. That the air tank be drained by removing the drain plug each trip.

6th. That especial attention be given to the proper seating of non-return check valve 5.

7th. That the combination cock be kept ground in, and the water valves and pipes be kept tight.

8th. That a card of instructions be issued for the information and government of employees whose duty it is to care for the system.

9th. That an efficient system of maintenance be inaugurated that will insure the air-brake system from interference of the water-raising system; for your committee believes that by such measures only can the present relationship between the water-raising system and the air-brake system be safely continued.

In the discussion which followed Mr. Jesson, chairman of the committee, said that the changes made in the apparatus by the makers were so numerous that it was hard to keep posted on the latest; furthermore, such a thing as making the valves easily accessible, does not appear to be considered, and they are stuck in any out-of-the-way place. Mr. Nellis said that he had found several slid wheels caused by the device, and in each case they were due to leakage in the non-return check, valve 5, which in the operation of the brake practically added the volume of the air tanks to the auxiliary reservoir, and caused a high cylinder pressure. The sleeping-car employees, who ought to know something about the system, were more ignorant of it than any one else. It also developed during the discussion that the system was only used on Pullman sleepers and private cars, the Wagner company not using it because it had not found it satisfactory.

The next report to be read was on the "Economical Lubrication of Air-Brake Cylinders." The committee gave the average cost of oiling and cleaning an 8-inch freight cylinder as 9 cents, and a 10-inch passenger cylinder as 12 cents, but it showed that where the freight cylinders were badly located the cost has risen as high as 60 cents. Its recommendations cover the same ground as the report, and are as follows:

1st. Air-brake cylinders on freight and passenger cars should never be oiled without at the same time being cleaned.

2d. Freight-brake cylinders should be cleaned once every twelve months and oiled with a heavy oil or light grease that is but little affected by changes in temperature, and will not gum within the period mentioned.

3d. Passenger-brake cylinders should be cleaned and oiled with a heavy oil or light grease at least once in twelve months, and not oftener than once in six months.

4th. While not absolutely necessary, there is an advantage to be gained in giving the piston a one-half turn every six months.

5th. Greater care in the location of air-brake cylinders on freight cars, particularly coal, ore and other special cars, would result in a large reduction in the cost of cleaning the same.

In the discussion Mr. Pratt, of the C. & N. W. Railway, said that he was glad to see a period of one year recommended for cleaning of freight car cylinders, for his road had adopted that rule several years ago and were satisfied with the results. Mr. McKee said that he had made a test of West Virginia well oil, Kent's compound, and another grease, in car cylinders on the Great Northern road; after five months the well oil had entirely disappeared, the grease whose name is not given had kept the packing in good condition, but the walls of the cylinder showed that lubrication would soon be necessary, while the cylinders to which Kent's compound had been applied were in as good condition as at the beginning of the test and were evidently good for the total period of twelve months recommended by the committee. Several other members testified as to the excellence of this compound for car and driver brake cylinders.

The report on "Maintenance of Passenger and Freight Brakes" was then read. It outlined what is required in air-brake test plants, illustrated methods of piping, also several portable stands for brake valves, a rack for testing triples, described methods and tools required for yard work, a form for reporting work on air-brakes, methods for getting the right leverage on cars and defect cards for brakes. The committee recommended clearing drain cups by disconnecting the union, swabbing the screen with a wire brush to loosen the dirt, and then blowing it out.

(Concluded on page 83.)

A Noiseless Compound Switching Locomotive.

As most of our readers probably know the Grand Central Station of the New York Central Railroad, as its name implies, is located in the center of New York, the approach to it being by an underground road which emerges into the open a short distance north of the station. The switching of the passenger trains required by its immense traffic must therefore be done in close proximity to resident streets on each side of it. Long ago the use of steam whistles, by switching engines, was prohibited, except in cases of great emergency. But even when whistles were not heard the sharp and loud exhaust of engines in starting heavy trains was and still is a great annoyance. During the past quarter of a century or more Mr. Buchanan, the Superintendent of Machinery of this line, and the architect of the celebrated 990, has experimented with and applied all kinds of devices to make the engines, which are used in the streets of New York

noiseless. These appliances had varying degrees of success, but they only partially mitigated the evil. The advent of the compound locomotive suggested to Mr. Buchanan a solution of the difficulty, and some months ago he designed the switching engine, which is illustrated herewith, an order for which was given to the Schnectady Locomotive Works, where it has recently been completed and is now at work on the tracks adjoining the Grand Central Station in New York.

As shown by the perspective view the engine has six coupled wheels, which are 51 inches in diameter, with a total base of 11 feet 6 inches. It is a two-cylinder compound, the high-pressure cylinder being 19 inches, and the low-pressure 29 inches in diameter by 24-inch stroke.

The special feature of the engine is the arrangement for making the exhaust noiseless. This consists of a receiver, which is attached to the middle of the cylinder castings, and is shown just below the extended smokebox in the perspective view, and also in outline in Fig. 2. In the inside it has a horizontal diaphragm which leaves a space below it, into which the exhaust steam from the low-pressure cylinder is discharged through the pipe below. The re-

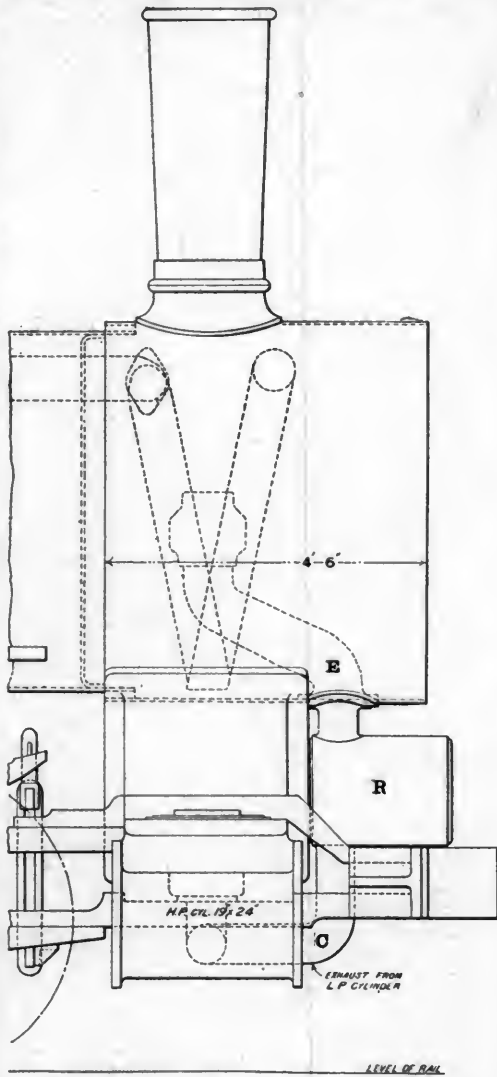


Fig. 2.—Outline of Front End of Locomotive.

ceiver also has two vertical diaphragms with holes shown in Fig. 3. The exhaust steam enters through the lower pipe, and passes under the horizontal diaphragm and through the holes in those which are vertical, and escapes up the chimney through the pipe at the top, which has a variable exhaust, shown by Figs. 4, 5 and 6—4 being a sectional view, and 5 and 6 end and plan views respectively. The upper end of this pipe has a revolving collar or sleeve on the outside of the central part. This sleeve rests on inclined guides, one of which is shown in Fig. 5. By turning this sleeve it is raised up through the action of the guides which thus leaves an annular opening between the sleeve and the inner pipe, whose size and area can be varied at pleasure. The central opening of the pipe always remains the same, but the total area for the escape of the exhaust steam is increased by the annular opening when the sleeve is raised up.

In the perspective view a relief valve is shown attached to the front end of the steam chest. This valve is connected to the receivers by a pipe, which is also shown in the view. A similar valve is attached to the high-pressure steam chest on the other side of the engine. The object of these valves is to maintain the pressure in the steam chests below a certain limit, and thus avoid an excessive pressure in either of the cylinders, and a consequent loud exhaust from that cause.

The engine is provided with Ashton blow back valves, which discharge the escaping steam into the tender.

The engine has been working very successfully for several

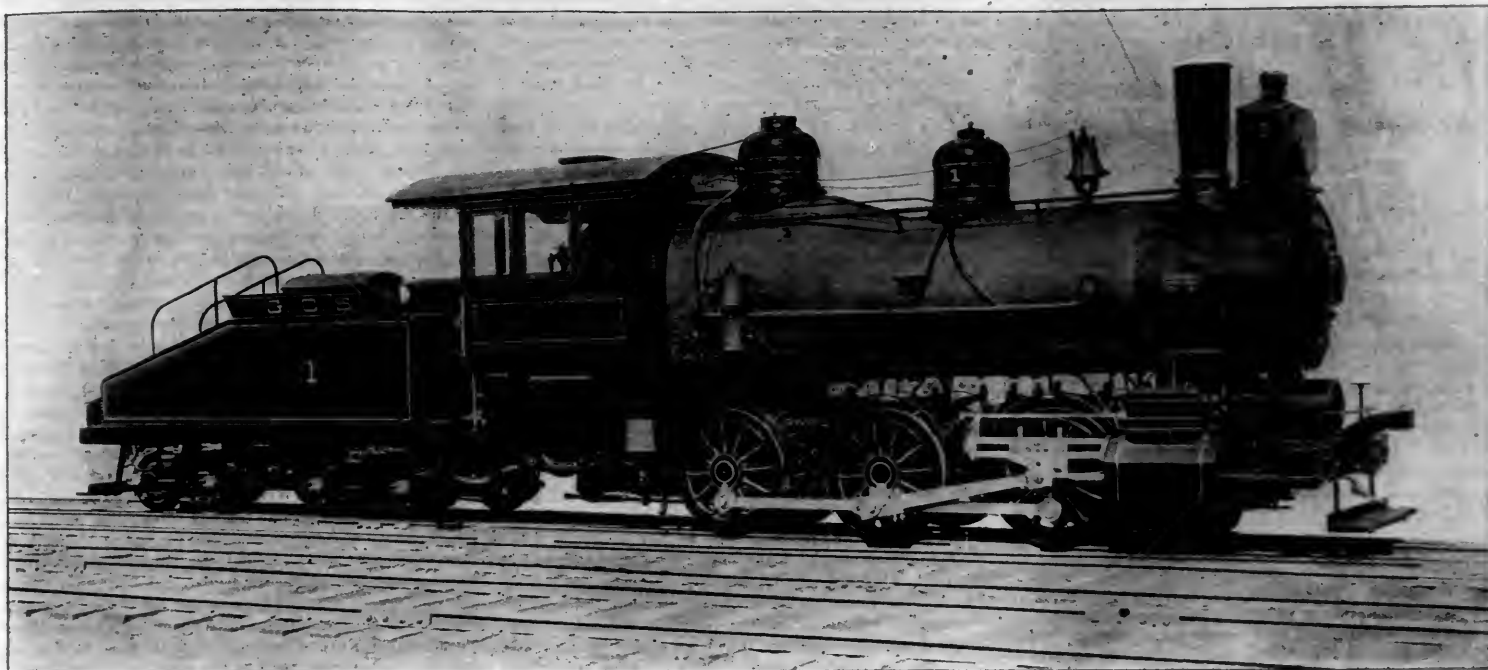


Fig. 1.

Compound Noiseless Switching Locomotive, for the New York Central & Hudson River Railroad

Designed by Mr. Wm. Buchanan, Superintendent of Motive Power.

Built by the Schenectady Locomotive Works, Schenectady, N. Y.

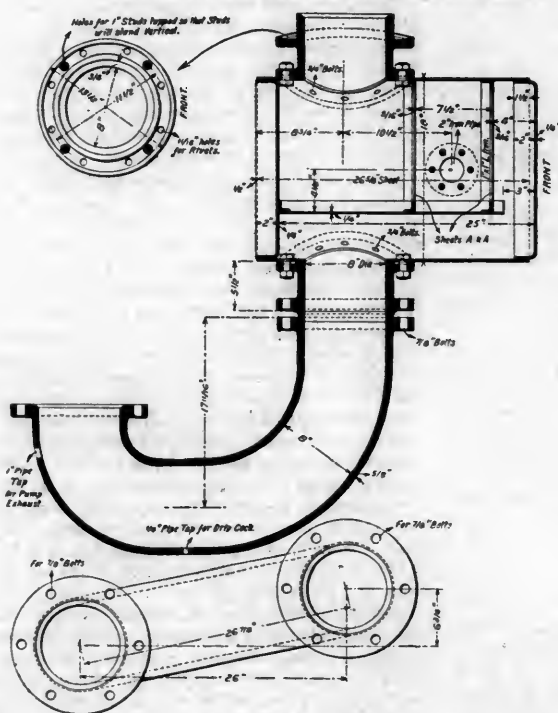


Fig. 3.
Exhaust Box.—Compound Switching Locomotive.

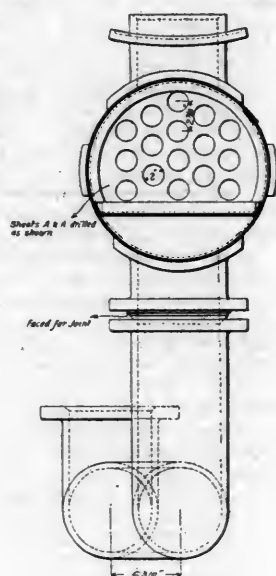


Fig. 4.

Lead of valves in full gear..... $\frac{1}{8}$ in.
Kind of valve stem packing..... United States metallic.

Wheels, etc.

Wheels, etc.	
Diameter of driving wheels outside of tire.....	51 in.
Material " " centers.....	Steel cast iron.
Tire held by.....	Shrinkage.
Driving box material.....	Steel cast iron.
Diameter and length of driving journals.....	5 in. dia. x 5 in.
" " main axle pin journals.....	5 1/2 in. dia. x 5 in.
" " side rod.....	Main 5 1/2 in. dia. x 5 in. F. & B. 4 1/2 in. dia. x 3 1/2 in.

Boilers

Style.....	Wagon top.....
Outside diameter of first ring.....	..... 50 in.
Working pressure.....	..... 181 lbs.
Material of barrel and outside of firebox.....	..... Carbon steel
Thickness of plates in barrel and outside of fire box.....	.....
Firebox, length.....	Throat $\frac{3}{4}$ ft., balance $\frac{1}{2}$ in.
" width.....	..... 16 $\frac{1}{2}$ in.
" material.....	..... Carbon steel
" crown staying.....	5 in. \times $\frac{3}{4}$ in. crown bars welded at ends
" stay bolts.....	..... 1 in. dia.
Tubes, material.....	Mild steel No. 11 W. G.
" number of.....	..... 11
" diameter.....	..... 1 in.
" length over tube sheets.....	..... 11 ft. 0 in.
Heating surface, tubes.....	..... 157.8 sq. ft.
" firebox.....	..... 162 sq. ft.
" total.....	..... 1702.5 sq. ft.
Grate.....	..... 31 sq. ft.
Exhaust pipes.....	Single, muffed through exhaust box
" nozzles.....	Variable 5 in. and 8 in. dia.

Tender.

Weight, empty	28,566 lbs.
Wheels, number	8
" diameter	30 in.
Journal, " and length	3 1/2 in. 4 1/2 x 7 in.
Wheel base	10 ft.
Tender frame, " L. V. Standard	6 1/2 in. x 4 in. x 3/4 in. angle iron
" trucks	channel from center bearing
Water capacity	3,900 gal.
Coal	3 1/2 tons
Total wheel base of engine and tender	39 ft. 6 1/2 in.

The engine house is fitted with Westinghouse-American combined brakes on all drivers, tender and for train, magnesia sectional boiler covering, one 3-inch Consolidated muffled and one 3-inch Ashton blow back safety valve and central steel brakebeams.

weeks, and while it cannot be said that it is at all times absolutely noiseless, it is true that the only time when any noise is heard is during the first two or three revolutions after starting when a very soft discharge is perceptible. After that a person a few yards away could not tell from the sound of the exhaust, that a locomotive was at work near them. This plan seems to afford the means of making the exhaust of locomotives so nearly perfectly noiseless that it will not be a cause of disturbance or annoyance to those who live, work or sleep in the closest proximity to them.

The engine steams very freely notwithstanding the fact that the exhaust is noiseless, but which seems to have sufficient effort upon the fire to maintain steam at the required pressure, which is 190 pounds.

The following are the principal dimensions of this engine:

General Dimensions.

Gage.....	4 ft. 8½ in.
Fuel.....	Anthracite coal
Weight in working order.....	125,000 lbs.
on drivers.....	125,000 lbs.
Wheel base, driving.....	11 ft. 6 in.
rigid.....	11 ft. 6 in.

Cylinders.

Diameter of cylinders.....	20 R. H. 19 in. L. H.
Stroke of piston.....	24 in.
Horizontal thickness of piston.....	5½ in. at hub, 4½ in. at rim.
Diameter of piston rod.....	3½ in.
Kind.....	United States metallic.
Size of steam ports.....	
.....	L. F. R. H. 30 in. × 1¼ in. H. P. L. H. 13 in. × 1¼ in.
Size of exhaust ports.....	L. P. R. H. 30 in. × 1 in. H. P. L. H. 13 in. × 1 in.
..... bridges.....	1½ in.

Valves.

Kind of slide valves.....	Richardson balanced.
Greatest travel of slide valves.....	5½ in.
Outside lap " " "	L. P. R. H. ½ in. H. P. L. H. ¾ in.
Inside lap " " "	L. P. R. H. ¼ in. H. P. L. H. ½ in.

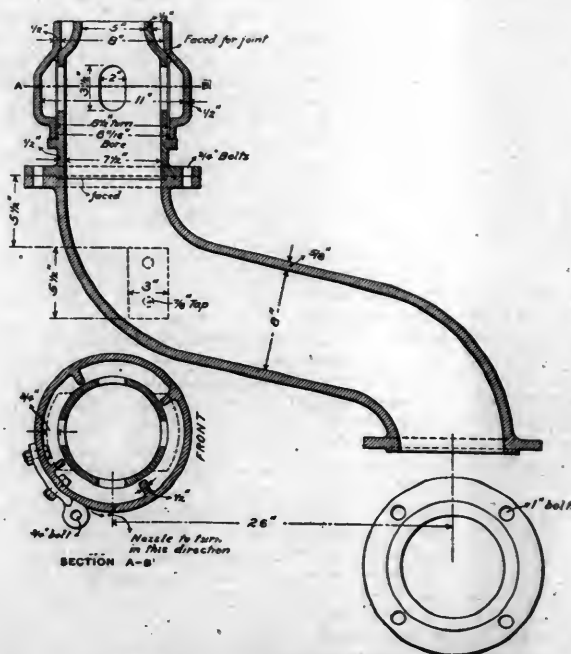


Fig. 5. Variable Exhaust.—Compound Switching Locomotive.

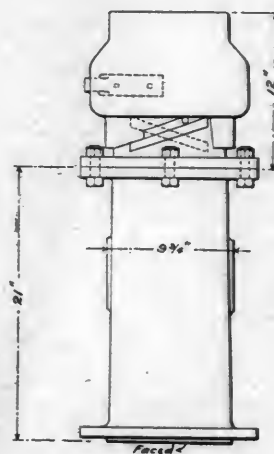


Fig. 6.

Third Annual Convention of the Association of Railroad Air-Brake Men.

The third annual convention of the Association of Railroad Air-Brake Men met at the American House, Boston, Mass., at 9 a. m., April 11, President Hutchins in the chair. Prof. George F. Swain, of the Massachusetts Institute of Technology and member of the State Railroad Commission, made an excellent opening address, in which he gave some figures illustrating the comparative safety of railroad travel. Much of this safety he attributed to the efficiency of the air-brake, and increased speeds with safety as great as at present he held can only be obtained by greater intelligence in the use of the brake, better maintenance, and a more general equipment of cars with it. Hence the importance of the association's work. He also believed that it was actual economy for the railroads to spend money for freight brakes, because of the economies in train operation resulting therefrom, the safety and speed, and even the decreased headroom required for overhead bridges when men no longer have to walk on top of the cars of a train. In closing his remarks he welcomed the association to the city and expressed the hope that the convention would be a most profitable one.

President Hutchins replied for the association and then proceeded to read his address. He spoke of the rapid growth of the association to a membership of over 200 in three years, its good standing financially, the value of its work being recognized by the purchase of the reports of its proceedings to a phenomenal extent, and to the general interest taken in its work. He touched on high speeds and the high-speed brake, slack adjusters and other improvements, but he emphasized the fact that the great work of the association was to suggest and carry out in practice betterments in the instruction of the men who handle the air-brakes and to attain a higher standard in the maintenance of the brakes. To do this they needed the support of superior officials, instruction cars and test yards. Air-brake cars should be ordered to the head of the train and used regularly. Occasionally we hear of a road ordering its men not to use the air on freight trains. Instead of being an exhibition of old foginess it may be a punishment for rough handling of trains. In such cases the order might eventually do good as the men will use the brakes even if they have to steal their use and at such times they will learn to handle them with care to avoid detection. In closing, he complimented the association on the promptness with which it handled its business last year and hoped it would do as well in this convention.

The Secretary's and Treasurer's reports showed the membership to be 216, and the funds in the treasury, March 31, to be \$922.35. Since that date \$118 had been received, making over \$1,000 in the treasury. Practically the entire edition of last year's proceedings, 2,000 copies, had been sold except the small number distributed to the members.

Several communications were then read; one from the New England Railroad Club, invited the members to attend its meeting held on the evening of the 14th; the New York, New Haven & Hartford Railroad invited the association to make an excursion over its line to Plymouth; the Pittsburgh Railroad invited them to visit the interlocking plant at its Boston terminals, and Sherburne & Company invited them to visit its offices and see a sanding apparatus worked in conjunction with the air-brake. These invitations were accepted, and the various trips taken at hours that did not interfere with the sessions of the convention.

The first report of committees to be read was that on "Piston Travel." This report is a voluminous but an admirable one. It discusses the loss of air in brake applications when the piston travels are uniformly long, the evils of various lengths of travel in the same train resulting in slid wheels, etc.; lost travel or that part of the travel resulting from slack in truck bolsters, center plates, boxes, deflecting brakebeams, etc.; and records the results of tests made on the St. Paul & Duluth Railroad, with cylinders having indicators attached. Rules are suggested for air-brake tests of trains arriving at division terminals. The report closes with the following recommendations:

1st. That yard tests be made from a 90 pounds train pipe pressure and a full service application, and piston travel adjustments, based on this, be made 5½ inches for freight and 7 inches for passenger.

2d. That road tests be made from not less than 50 pounds pressure for freight and 60 pounds for passenger, and that readjustments be made to between 5 and 6 inches on freight and 6 and 7 inches on passenger where found less than 1½ inches on freight and 5½ inches on passenger, or where over 8 inches on either.

3d. That brake cylinders of such size be employed as recommended in Westinghouse Air-Brake Company's circular of Dec. 1, 1895, that total leverage necessary to employ may not be excessive.

4th. That brake rigging (including beams) of sufficient strength be employed as will reduce deflection to a minimum.

5th. That lost travel due to truck construction and wear be as much reduced as possible.

The discussion was brief and was chiefly on the recommendation to use 60 pounds pressure for a yard test. Some claimed that it could not be obtained in many yards because of low steam pressure, and others doubted the wisdom of it, but the majority were in favor of it.

The next report to be considered was that on "Slack Adjusters." The value of a good slack adjuster was admitted but the committee had not found any device that could be pronounced perfect. It desired what an adjuster should do to fill the bill, the most desirable location for it, and the effect of the change in angularity of the brake levers as the slack is taken up. The committee conducted tests on this point to satisfy the doubting Thomas's and found the brake power was practically constant for large variations in the angularity of the levers.

The discussion brought out nothing new but served to emphasize the need of practical and successful devices of this kind.

The committee appointed to formulate a series of questions and answers on the air-brake next reported. Its report involved an immense amount of labor, but on account

of its length—their being nearly 500 questions with their answers—it could not be discussed to advantage. It was disposed of by being ordered printed, and the committee requested to meet after the session to listen to any arguments which members might present to them on any part of the report.

The second day's business of the convention began with the reading of the report on "Water-Raising Systems on Sleeping Cars." The report describes the four different methods used up to date, and illustrates them. If the committee had done nothing else, its work would have been important, as information along this line has not been complete by any means. It recommends a method of testing, and closes with the following recommendations:

1st. That all water-raising systems using the first and second methods be changed to the third method.

2d. That a duplex air gage be placed in the wash-room of all sleeping cars using the water-raising system, and that the red hand be connected to the air pressure tank, and the black hand to the water tanks.

3d. That the reducing valve be regulated to permit but 20 pounds of air pressure on the water tanks.

4th. That the air pressure governor valve and the pressure reducing valve be given a more accessible location, and that "Governor Valve" and "Reducing Valve" be plainly stenciled on the door of the box containing them.

5th. That the air tank be drained by removing the drain plug each trip.

6th. That especial attention be given to the proper seating of non-return check valve 5.

7th. That the combination cock be kept ground in, and the water valves and pipes be kept tight.

8th. That a card of instructions be issued for the information and government of employees whose duty it is to care for the system.

9th. That an efficient system of maintenance be inaugurated that will insure the air-brake system from interference of the water-raising system; for your committee believes that by such measures only can the present relationship between the water-raising system and the air-brake system be safely continued.

In the discussion which followed Mr. Jesson, chairman of the committee, said that the changes made in the apparatus by the makers were so numerous that it was hard to keep posted on the latest; furthermore, such a thing as making the valves easily accessible, does not appear to be considered, and they are stuck in any out-of-the-way place. Mr. Nellis said that he had found several slid wheels caused by the device, and in each case they were due to leakage in the non-return check, valve 5, which in the operation of the brake practically added the volume of the air tanks to the auxiliary reservoir, and caused a high cylinder pressure. The sleeping-car employees, who ought to know something about the system, were more ignorant of it than any one else. It also developed during the discussion that the system was only used on Pullman sleepers and private cars, the Wagner company not using it because it had not found it satisfactory.

The next report to be read was on "Economical Lubrication of Air Brake Cylinders." The committee gave the average cost of oiling and cleaning an 8-inch freight cylinder as 9 cents, and a 10-inch passenger cylinder as 12 cents, but it showed that where the freight cylinders were badly leaked the cost has risen as high as 60 cents. Its recommendations cover the same ground as the report, and are as follows:

1st. Air-brake cylinders on freight and passenger cars should never be oiled without at the same time being cleaned.

2d. Freight-brake cylinders should be cleaned once every twelve months and oiled with a heavy oil or light grease that is but little affected by changes in temperature, and will not gum within the period mentioned.

3d. Passenger-brake cylinders should be cleaned and oiled with a heavy oil or light grease at least once in twelve months, and not oftener than once in six months.

4th. While not absolutely necessary, there is an advantage to be gained in giving the piston a one-half turn every six months.

5th. Greater care in the location of air-brake cylinders on freight cars, particularly coal, ore and other special cars, would result in a large reduction in the cost of cleaning the same.

In the discussion Mr. Pratt, of the C. & N. W. Railway, said that he was glad to see a period of one year recommended for cleaning of freight car cylinders, for his road had adopted that rule several years ago and were satisfied with the results. Mr. McKee said that he had made a test of West Virginia well oil, Kent's compound, and another grease, in car cylinders on the Great Northern road; after five months the well oil had entirely disappeared, the grease whose name is not given had kept the packing in good condition, but the walls of the cylinder showed that lubrication would soon be necessary, while the cylinders to which Kent's compound had been applied were in as good condition as at the beginning of the test, and were evidently good for the total period of twelve months recommended by the committee. Several other members testified as to the excellence of this compound for car and driver brake cylinders.

The report on "Maintenance of Passenger and Freight Brakes" was then read. It outlined what is required in air-brake test plants, illustrated methods of piping, also several portable stands for brake valves, a rack for testing trips, described methods and tools required for yard work, a form for reporting work on air-brakes, methods for getting the right leverage on cars and defect cards for brakes. The committee recommended clearing drain cups by disconnecting the union, swabbing the screen with a wire brush to loosen the dirt, and then blowing it out.

(Concluded on page 83.)

A Noiseless Compound Switching Locomotive.

As most of our readers probably know the Grand Central Station of the New York Central Railroad, as its name implies, is located in the center of New York, the approach to it being by an underground road which emerges into the open a short distance north of the station. The switching of the passenger trains required by its immense traffic must therefore be done in close proximity to resident streets on each side of it. Long ago the use of steam whistles, by switching engines, was prohibited, except in cases of great emergency. But even when whistles were not heard the sharp and loud exhaust of engines in starting heavy trains was and still is a great annoyance. During the past quarter of a century or more Mr. Buchanan, the Superintendent of Machinery of this line, and the architect of the celebrated 999, has experimented with and applied all kinds of devices to make the engines which are used [in] the streets of New York

noiseless. These appliances had varying degrees of success, but they only partially mitigated the evil. The advent of the compound locomotive suggested to Mr. Buchanan a solution of the difficulty, and some months ago he designed the switching engine, which is illustrated herewith, an order for which was given to the Schnectady Locomotive Works, where it has recently been completed and is now at work on the tracks adjoining the Grand Central Station in New York.

As shown by the perspective view the engine has six coupled wheels, which are 51 inches in diameter, with a total base of 11 feet 6 inches. It is a two-cylinder compound, the high-pressure cylinder being 19 inches, and the low-pressure 29 inches in diameter by 24-inch stroke.

The special feature of the engine is the arrangement making the exhaust noiseless. This consists of a receiver, which is attached to the middle of the cylinder castings, and is shown just below the extended smokebox in the perspective view, and also in outline in Fig. 2. In the inside it has a horizontal diaphragm which leaves a space below it, into which the exhaust steam from the low-pressure cylinder is discharged through the pipe below. The re-

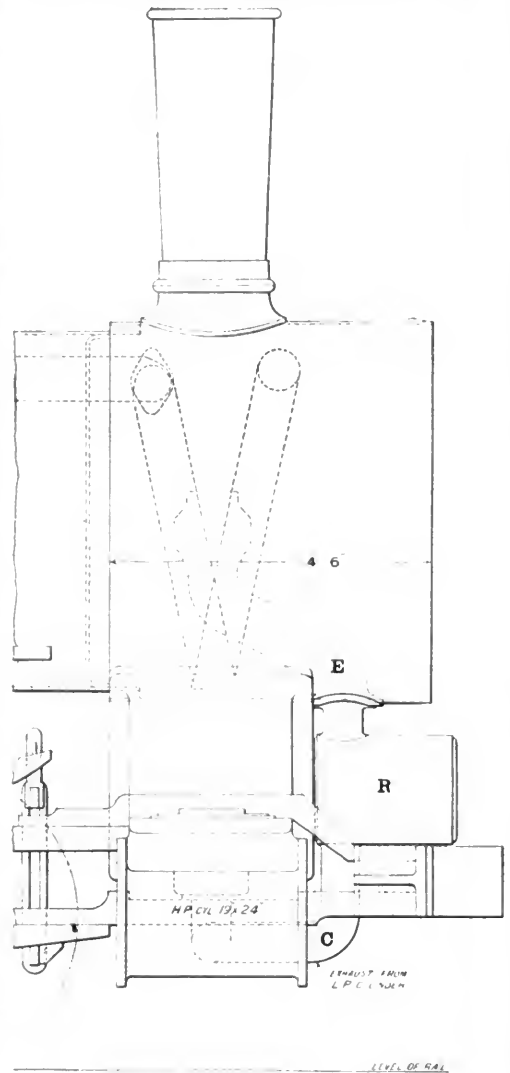


Fig. 2—Outline of Front End of Locomotive.

ceiver also has two vertical diaphragms with holes shown in Fig. 3. The exhaust steam enters through the lower pipe, and passes under the horizontal diaphragm and through the holes in those which are vertical, and escapes up the chimney through the pipe at the top, which has a variable exhaust, shown by Figs. 4, 5 and 6—being a sectional view, and 5 and 6 end and plan views respectively. The upper end of this pipe has a revolving collar or sleeve on the outside of the central part. This sleeve rests on inclined guides, one of which is shown in Fig. 5. By turning this sleeve it is raised up through the action of the guides which thus leaves an annular opening between the sleeve and the inner pipe, whose size and area can be varied at pleasure. The central opening of the pipe always remains the same, but the total area for the escape of the exhaust steam is increased by the annular opening when the sleeve is raised up.

In the perspective view a relief valve is shown attached to the front end of the steam chest. This valve is connected to the receivers by a pipe, which is also shown in the view. A similar valve is attached to the high-pressure steam chest on the other side of the engine. The object of these valves is to maintain the pressure in the steam chests below a certain limit, and thus avoid an excessive pressure in either of the cylinders, and a consequent loud exhaust from that cause.

The engine is provided with Ashton blow back valves, which discharge the escaping steam into the tender.

The engine has been working very successfully for several

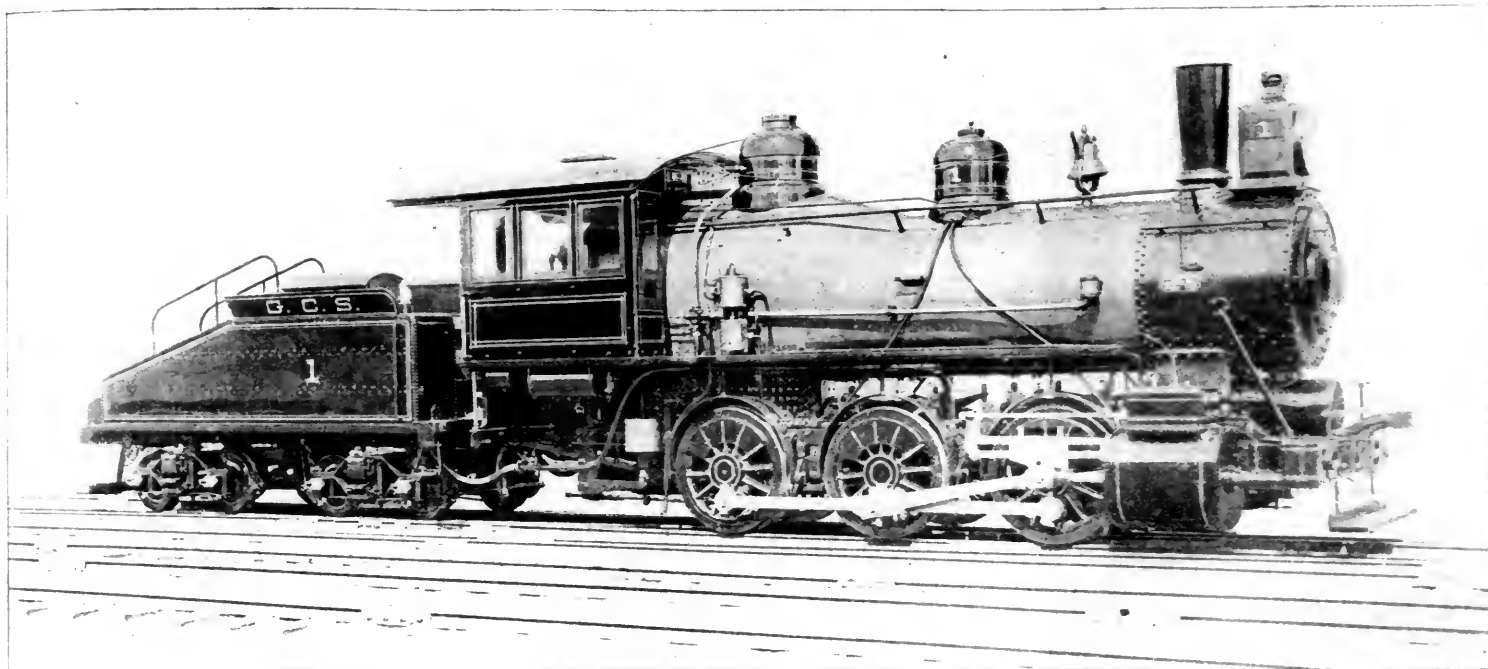


Fig. 1.

Compound Noiseless Switching Locomotive, for the New York Central & Hudson River Railroad.

Designed by Mr. Wm. Buchanan, Superintendent of Motive Power.

Built by the Schenectady Locomotive Works, Schenectady, N. Y.

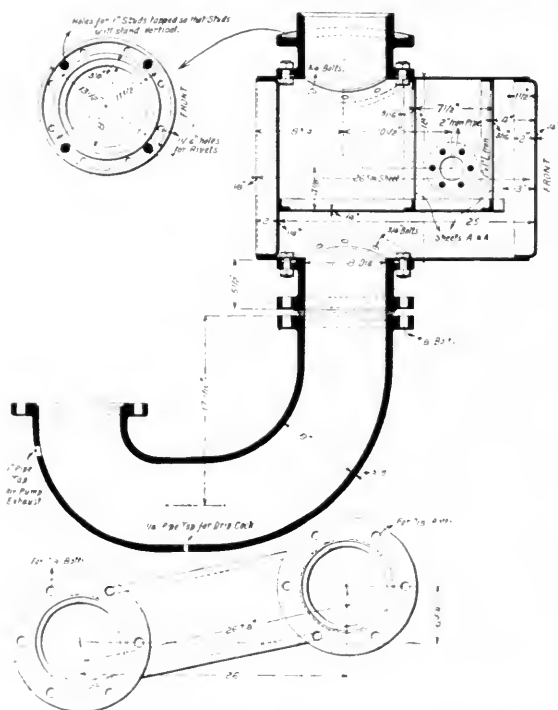


Fig. 3.
Exhaust Box.—Compound Switching Locomotive

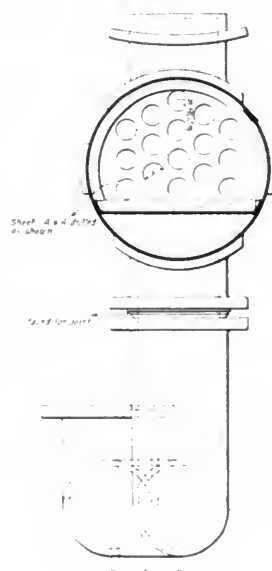


Fig. 4.

Lead of valves in full gear	.....	1 in.
Kind of valve stem packing	.....	United States metallic.
Wheels, etc.		
Diameter of driving wheels outside of tire	.....	51 in.
Material " centers	.....	Steel cast iron.
Tire held by	.....	Shrinkage.
Driving box material	.....	Steel cast iron.
Diameter and length of driving journals	.....	8 in. dia. x 3 in.
" " main crank pin journals	.....	5 1/2 in. dia. x 3 in.
" " side rod	.....	Main 3 1/2 in. dia. x 3 in. F. & B. 4 1/2 in. dia. x 3 1/2 in.
Boilers.		
Style	.....	Wagon ton.
Outside diameter of first ring	.....	80 in.
Working pressure	.....	180 lbs.
Material of barrel and outside of firebox	.....	Carbon steel.
Thickness of plates in barrel and on side of fire box	.....	Throat 3/4 in., balance 1/2 in.
Firebox, length	.....	107 1/2 in.
" width	.....	42 in.
" material	.....	Carbon steel.
" crown staying	.....	5 in. x 3/4 in. crown bars welded at ends.
" stay bolts	.....	1 in. dia.
Tubes, material	.....	Mil. steel No. 11 W. G.
" number of	.....	271
" diameter	.....	2 in.
" length over tube sheets	.....	11 ft. 6 in.
Heating surface, tubes	.....	1575 sq. ft.
" firebox	.....	162 sq. ft.
" total	.....	1737 sq. ft.
Grate	.....	31.21 sq. ft.
Exhaust pipes	.....	Single, muffled through exhaust box.
nozzles	.....	Variable 5 in. and 8 in. dia.
Tender.		
Weight, empty	.....	28,500 lbs.
Wheels, number of	.....	8
" diameter	.....	30 in.
Journals	.....	3 1/2 in. dia. x 3 in.
Wheel base	.....	14 ft. 6 in.
Tender frame	.....	1 1/2 W. standard, 6 1/2 in. x 4 in. x 3/4 in. angle iron
channel iron center bearing	.....
Water capacity	.....	3,000 U. S. gallons
Coal	.....	3 1/2 tons
Total wheel base of engine and tender	.....	38 ft. 3 1/2 in.
length	.....	52 ft. 4 1/2 in.

The engine house is fitted with Westinghouse-American combined brakes on all drivers, tender and for train, magna sectional boiler covering, one 3-inch Consolidated muffled and one 3-inch Ashton blow back safety valve and central steel brakebeams.

weeks, and while it cannot be said that it is at all times absolutely noiseless, it is true that the only time when any noise is heard is during the first two or three revolutions after starting when a very soft discharge is perceptible. After that a person a few yards away could not tell from the sound of the exhaust, that a locomotive was at work near them. This plan seems to afford the means of making the exhaust of locomotives so nearly perfectly noiseless that it will not be a cause of disturbance or annoyance to those who live, work or sleep in the closest proximity to them.

The engine steams very freely notwithstanding the fact that the exhaust is noiseless, but which seems to have sufficient effort upon the fire to maintain steam at the required pressure, which is 190 pounds.

The following are the principal dimensions of this engine:

General Dimensions.

Gage	.....	4 ft. 8 1/2 in.
Fuel	.....	Anthracite coal
Weight in working order	.....	125,000 lbs.
" on drivers	.....	125,000 lbs.
Wheel base, driving	.....	11 ft. 6 in.
" rigid	.....	11 ft. 6 in.

Cylinders.

Diameter of cylinders	.....	29 R. H. 19 in. L. H.
Stroke of piston	.....	21 in.
Horizontal thickness of piston	.....	5 1/4 in. at hub, 1 3/4 in. at rim.
Diameter of piston rod	.....	3 1/4 in.
Kind	.....	Packing
" rod packing	.....	Plain rings of cast iron.
Size of steam ports	.....	United States metallic.
L. P. R. H. 20 in. x 1 1/4 in. H. P. L. H. 13 in. x 1 1/4 in.	.....
Size of exhaust ports, L. P. R. H. 20 in. x 3 in. H. P. L. H. 13 in. x 3 in.	.....
" bridges	.....	1 1/4 in.

Valves.

Kind of slide valves	.....	Richardson balanced.
Greatest travel of slide valves	.....	3 1/2 in.
Outside lap	.....	L. P. R. H. 7/8 in. H. P. L. H. 1 1/2 in.
Inside lap	.....	L. P. R. H. 7/8 in. H. P. L. H. 1 1/2 in.

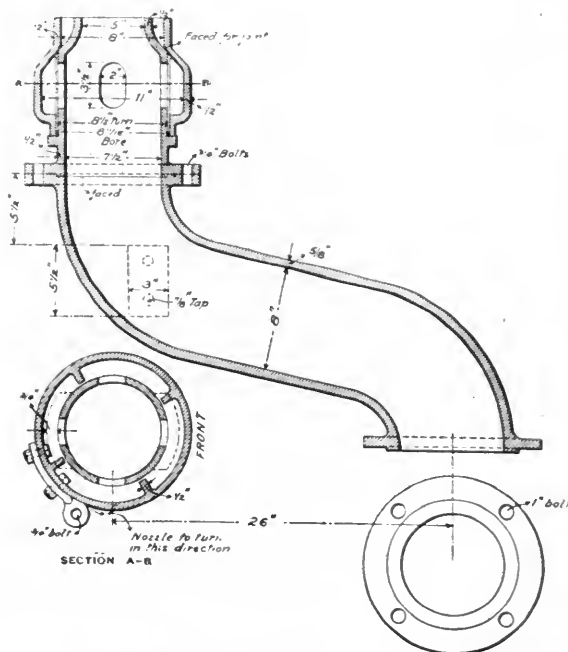


Fig. 5.

Variable Exhaust.—Compound Switching Locomotive

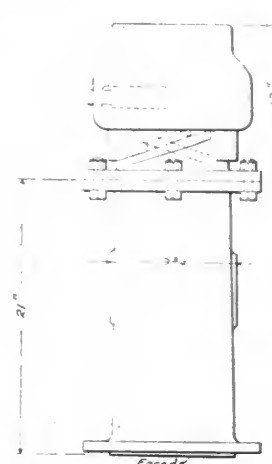


Fig. 6.

(Established 1832.)

AMERICAN ENGINEER CAR BUILDER AND RAILROAD JOURNAL

27TH YEAR.

65TH YEAR.

PUBLISHED MONTHLY

BY
R. M. VAN ARSDALE,

MORSE BUILDING.....NEW YORK.

M. N. FORNEY,
W. H. MARSHALL, } Editors.

ADVERTISING.

F. H. CLARKE, Morse Building, New York.
R. G. CHASE, 705 Western Union Building, Chicago.

MAY, 1896.

Subscription.—\$2.00 a year for the United States and Canada;
\$2.50 a year to Foreign Countries embraced in the Universal
Postal Union.

EDITORIAL ANNOUNCEMENTS.

Advertisements.—Nothing will be inserted in this journal for pay, EXCEPT IN THE ADVERTISING PAGES. The reading pages will contain only such matter as we consider of interest to our readers.

Special Notice.—As the AMERICAN ENGINEER, CAR BUILDER AND RAILROAD JOURNAL is printed and ready for mailing on the last day of the month, correspondence, advertisements, etc., intended for insertion must be received not later than the 25th day of each month.

Contributions.—Articles relating to railway rolling stock construction and management and kindred topics, by those who are practically acquainted with these subjects, are specially desired. Also early notices of official changes, and additions of new equipment for the road or the shop, by purchase or construction.

To Subscribers.—The AMERICAN ENGINEER, CAR BUILDER AND RAILROAD JOURNAL is mailed regularly to every subscriber each month. Any subscriber who fails to receive his paper ought at once to notify the postmaster at the office of delivery, and in case the paper is not then obtained this office should be notified, so that the missing paper may be supplied. When a subscriber changes his address he ought to notify this office at once, so that the paper may be sent to the proper destination.

The paper may be obtained and subscriptions for it sent to the following agencies: Chicago, Post Office News Co., 217 Dearborn Street. London, Eng., Sampson Low, Marston & Co., Limited, St. Dunstan's House, Fetter Lane, E. C.

The third annual convention of the Air-Brake Men's Association was held in Boston last month, and we would direct the attention of our readers to the proceedings as summarized elsewhere in this issue. While our account is necessarily brief, the proceedings of the convention were of a high order, and the business was handled in a prompt and thorough manner. The reports presented exhibit the results of thorough and painstaking work, and are a credit to the association. They compare favorably with the reports to the other and older associations, and in view of the importance of the subjects with which the association has to do, and the excellence of the work it has thus far accomplished, it certainly merits a continuation of its rapid rate of growth in numbers and influence.

On English railroads the passenger traffic is divided into several classes, of which the third class is by far the most numerous and, according to all reports, the only profitable one. Of recent years the second class traffic has dwindled to almost nothing, and one would think the railroad officials would be glad to abandon it. But the Great Western and London & South Western roads have reduced the second-class fares with the expectation of inducing third-class passengers to patronize the second class. It appears to be the general belief that this step may delay, but cannot postpone indefinitely, the abandonment of the second class.

The bills now before Congress known as the "Wilson-Squire" bills, have for their object a revision of such rules and regulations of the navy as effect the status and authority of engineers. They provide for an increase in the number of the corps, which shall be in proportion to the increase of naval vessels; for the admission of graduates from civilian engineering schools to the corps, the establishment of an engineering experimental station, and the transfer to the engineer corps of certain engineering duties now in other hands. The fact is that the rules as they now stand, with certain unimportant exceptions, were framed when steam was only an auxiliary to sails, and when naval engineers had comparatively few responsibilities. Naval duties are such as to require, for the good of the service and justice to individuals, that their standing should be a higher one and their authority greater than at present. Judging from the past the establishment of an experimental station would be productive of much

good, for it has been notably true of all experimental work undertaken by engineers in the employ of the government, that the time and money have been wisely expended. It appears that nearly every nation is or has been tardy in according to its naval engineers the status they deserve, but the agitation for justice to these officials has been strong and persistent. We trust that in the case of our own country it will result in much needed reforms.

The scheme of carrying the cars of the elevated roads of New York and Brooklyn over the bridge between the two cities so that passengers can make a continuous trip from any part of one city to any part of the other reached by the roads, is one that might meet with the approval of the traveling public if the details of the plan were more favorable to the two city governments. It is proposed that the roads shall pay a rental equal to the present earning power of the bridge railroad, the cities to pay for the changes at the terminals necessary for the through traffic, and the roads to charge only five cents for a ride from any station in one city to the further bridge terminal. The objection is urged that while this would eliminate the present bridge fare of three cents for such passengers as use both the elevated and the bridge, it would increase the fare from three to five cents to those who at present use the bridge only. The rental proposed is also held to be inadequate, especially on a lease for as long a period as 50 years, and it is pointed out that the cost of rearranging terminals and the payment of damages incidental thereto, all falls upon the cities, so that the railroads obtain the use of the bridge without any or but little initial outlay. The cry is also raised that the elevated roads will not operate the bridge road with the same regard to the safety of the public as has been exercised in the past, but that charge may surely be dropped in view of the record for safety already made by these roads in the conduct of their business. The plan might be a good one if the details can be arranged satisfactorily to all concerned, and the elevated trains sandwiched in between the regular bridge trains without confusion and delay, but it is doubtful if the percentage of the total traffic to be benefited by the change is sufficient to warrant the expense involved in the plan, unless other connections are made to the bridge in New York besides the east side lines.

The bill introduced into Congress making the metric system compulsory in this country after Jan. 1, 1901, has been sent back to the House committee and the probability of its being adopted in this session is very slim. It will be a good thing if it does not pass in its present form. We believe that the ultimate adoption of the metric system in this country is certain, but to make it compulsory and at such an early date is unwise and would work a hardship to many. Manufacturers who have considerable foreign business would probably reap sufficient benefit from it to offset the expense to them of the change, but there are many others who have no resulting advantages to look forward to, and these parties deserve more consideration than the bill mentioned gives them. If it is conceded that the adoption of the system will some time be an accomplished fact, then it is clear that the earlier the change is undertaken the less expensive it will be. The change should not be attempted without plenty of preparation, however, as without it the cost would be excessive and needlessly great. Such legislation as is desired in aid of this movement should be framed on more practical lines than the bill mentioned. The large manufacturers, if assured that only reasonable legislation was contemplated, would doubtless be able to suggest the lines on which a satisfactory law could be framed. They have a right to be heard in this matter, for upon them will come the great burden of a change. Expensive scales, templates, jigs, drawings, taps, dies, etc., would have to be changed, and this is one of the objections to a sudden and compulsory adoption of the system. But drawings become obsolete, and templates and special tools wear out, and if a reasonable period is allowed in which to effect the change, the manufacturing and engineering industries could doubtless provide a way for reducing to a minimum the confusion and expense incident thereto.

LOCOMOTIVE GRATES.

One of the subjects selected for investigation, and on which a report is to be made at the next convention of the Master Mechanics' Association, is that which forms the title of this article. Mr. H. Wade Hibbard is the chairman of this committee from whom, with the aid of his able coadjutors, an interesting report may be expected. There are some subjects in all departments of human activity and knowledge which are dragged along through years of rapid and fruitless discussion, which is productive of only negative results, and reveals little more than the fact that our knowledge concerning them is very limited. The subject of fire grates seems to be one of this kind. A vast amount of thought and ingenuity has been exercised in their design and construction, and innumerable patents have been taken out for inventions intended presumably to improve their operation, but the fact remains, that the combustion of coal is still a very imperfect and wasteful process. When converted into gas, very nearly perfect combustion of coal may be obtained, but when it is burned in its solid form a large percentage of its calorific value is wasted. Now

this is due very largely, it is believed, to what may be called the "environment" of the fire, and it seems probable that very considerable economy would be possible if what may be called the contingencies of combustion were investigated and adapted to produce the result aimed at. Thus we are not aware that any exhaustive experiments have ever been made to show what is the most advantageous width of grate bars and openings between them for burning different kinds of coal. Obviously if the bars are too thick when fine coal is burned there will be an imperfect dissemination of air through the fuel, and if the openings are too wide much of the coal will fall through and therefore will not be burned. If on the other hand the bars are too thin and the spaces too narrow the bars may melt out and the spaces be clogged by ashes or cinders or both. It is thought that the student will look in vain through engineering literature for satisfactory information with reference to the best width of bars and openings for burning given qualities or grades of coal. An investigation to show what forms and proportions of grates are best adapted to burn different qualities of fuel, under different conditions, would involve much labor and expense and it could hardly be expected that a committee constituted like the one referred to could give the time nor has it the money for such research, but a distinct advance would be made if they should merely formulate our ignorance of the subject.

It might very properly be asked of the Committee what are the best proportion of grates for burning, say, buckwheat, stove, or run of mine anthracite coal, or the different grades of bituminous, such as Cumberland, Pennsylvania, and the Western coals, which clinker very badly. In response to such enquiries the Committee would say that they don't know and cannot find out that anyone else does, it would be a gain.

Then there is the disputed question of the value of water grates for burning anthracite. On some roads these are being abandoned, and ordinary cast-iron grates are used instead. Of shaking grates for bituminous coal there is a great variety. Which are the best? The preferences which are felt by different master mechanics for certain types seem to rest on mere predilections, which have little or no sound facts or reasons to rest on.

Combustion, as every elementary book tells us, is a chemical combination of the carbon and hydrogen of the coal with the oxygen of the air. To effect this combination they must be brought into contact and there must be an igniting temperature. To produce perfect combustion it is therefore of the utmost importance that the grate should be so proportioned and constructed as to admit air to the coal so as to completely permeate the whole mass, and, what is perhaps of equal importance, is that the coal should be adapted to the grate. Every fireman knows that if the fuel which is thrown on the fire varies in size from large lumps to that which is almost pulverized, that not nearly such good results can be obtained as are possible if the large lumps are broken up and the coal is assorted, so that that which is burned is of nearly uniform size. In the latter case the grate can be adapted to the fuel which is used, and the supply of air may be much more uniformly distributed through it. This is impossible if large lumps are thrown on the fire, because the air can come in contact with the fuel so long as it is in the solid form only at its surface, and this is much greater in small than in large lumps in proportion to their bulk. Thus a spherical lump containing one cubic inch has very nearly five square inches of surface, whereas a lump containing ten cubic inches has only about two and a quarter square inches of surface per cubic inch of coal. It is therefore very much easier to bring the air into contact with the fuel when it is broken up into small pieces than it is if the fire is fed with large lumps. But if it is very fine it will pack closely, and then unless the grate has many small openings it is difficult to supply enough air to the whole mass.

To maintain good combustion it is essential, too, that the temperature of the fire should be kept above the point of ignition. If the temperature is reduced in any part of the fire below the point at which the gases will burn combustion is checked. Now, perhaps, few persons realize how much the temperature of a fire is reduced when fresh coal is thrown on it. It is not merely that the fuel must be heated from the external temperature to that of the fire, but as soon as the coal is heated it is converted into gas, and in that process a very large amount of heat is absorbed or becomes latent. Rankin called it the heat of gasification, which is very expressive. This phenomena is exemplified if we heat water in the atmosphere to a temperature of 212 degrees. To do this each pound of water will absorb 212 heat units, supposing its temperature was at zero in the beginning. If we continue to add heat the whole pound will be converted into steam, whose temperature will not be at any time exceed 212 degrees. But to vaporize it besides the 212 units to heat the water it will require 966 additional units to convert the water into a gas.

This is the heat of gasification which is absorbed or becomes latent when the water is changed from a liquid to a gaseous form. A similar phenomena occurs when fresh coal is thrown on the fire and is converted into gas, the effect of which is to absorb heat from the fire. If the amount so fed to the grate is excessive the temperature about the fresh fuel may be re-

duced below the igniting point and combustion is thus partially or wholly arrested. The fuel and the grate should therefore bear such a relation to each other that the former may be distributed over the latter and so that air may be admitted through the whole mass of the fuel. One of the problems presented to the committee then, is to formulate such proportions for grates, as will most effectually accomplish this result, with different kinds of coal.

But there are other questions relating to what has been called the environment of the fire which ought to be considered. In Kent's excellent *Mechanical Engineers' Pocket Book*, he quotes Rankin, who says, "if disengaged carbon is maintained at the temperature of ignition, and supplied with oxygen sufficient for its combustion, it burns while floating in the inflammable gas, and forms red, yellow or white flame. The flame itself is apt to be chilled by radiation, as into the heating surface of a steam boiler, so that the combustion is not completed, and part of the gas and smoke pass off unburned." The temperature of water in a boiler with a steam pressure of 150 pounds per square inch is only 366 degrees whilst the temperature of gaseous flame is about 4,000 degrees it will therefore be seen as observed by Frederick Siemens "what a quenching effect the metal of the boiler, which is of course at the temperature of the water, has upon the flames." He also called attention to the fact that "when flame is brought into contact with any solid body, it is more or less quenched, according to the substance, size and temperature of the body. Take any ordinary illuminating gas flame, such, for instance, as a bawling, and place a glass rod or tube into the middle of it, the flame will immediately burn dull, and a large quantity of lamp-black will be deposited on the piece of glass. This action is most marked when the rod is cold, but takes place, though in a less degree, at any temperature, for the reason that the material to be heated is necessarily always at a lower temperature than the flame, also owing to the disturbance in the combustion caused by contact of the solid substance with the flame." Continuing, this distinguished authority announces this important principle in relation to combustion—"experiments I have made," he says, "establish the following most important fact, namely, that a good flame, or in other words, perfect combustion can only take place in an open space or in one of sufficiently large size to allow the gases to burn out of contact with solid material." This principle, it is believed, is of very great importance in the combustion of coal especially in locomotives, many of which necessarily have a limited amount of space in their fireboxes. If these are too narrow, the flame must come in contact with the sides, and if they are shallow with the crown-sheet. Every fireman has observed how prone the fire in a locomotive firebox is to become dead along the sides and the front and back ends of the firebox.

The fire here is in contact with the cold surfaces, and the flame comes in contact with solid material. It would seem to be wise, then, to widen the fireboxes of locomotives, whenever this is possible, and give them ample depth. This, however, can only be done in new designs, and should undoubtedly be aimed at in all cases. But can nothing be done in the existing forms and proportions of fireboxes? The deadening effect referred to is due to the contact of the fuel and the fire with the sides of the firebox. This can be avoided by constructing the grates with dead plates or firebrick all around them and between the open part and the firebox plates. If these are inclined somewhat steeply they will keep the fuel away from the cold plates, or if made flat they will speedily be covered with ashes or cinders which will have the same effect. Combustion in a very shallow firebox would undoubtedly be improved by lowering the grate below the sides of the firebox when this is possible. The principle to which it is intended to direct the attention of the committee is that enunciated by Mr. Siemens, and the object to be aimed at is to construct grates so as "to allow the gases to burn out of contact with solid material," as far as that is possible.

Another matter is also worthy of their attention—that is, the rate of combustion on grates. It does not seem to be at all certain that the principle which has been hastily assumed that the slower the combustion the greater is the economy. There probably is some rate for locomotives which is more economical than any which is slower or faster, and it may be that this rate has some relations to the speed and the loads hauled. Be this as it may it seems very probable that a grate which is sufficiently large to be economical when the maximum demands are to be made on it, would be too large for economy when the engine is not consuming so much steam. This suggests a grate of variable size, which perhaps is worthy of consideration by the committee.

There has lately been some discussion with reference to the slope of grates in marine boilers and it has been advocated that instead of sloping downward from the furnace doors they should incline the reverse way. In locomotives sloping grates have always been made lower at the front end than behind. Is it quite certain that this is the best form of construction? In some kinds of engines this is essential in order to get the rear axle under the firebox, but in some other types it would be a distinct advantage to have it higher in front.

A collateral subject relating to grates is that of furnace doors. There can be no doubt of the fact that having the

furnace door open so large a portion of the time when a boiler is worked the hardest has a very deleterious effect upon the fire. Probably most engineers would agree that the steaming capacity of a locomotive boiler would be greatly diminished if the door was kept open all the time. There is every reason for believing that the deleterious effect of having the door open is in proportion to the time it is open. In ordinary hand firing probably the door is open one third of the time, the effect of which is just one-third as bad as though it was open all the time. Is not some form of automatic opening door possible or some way of feeding coal to the fire without opening communication wide for the admission of cold air?

The Committee has an opportunity of making an interesting and valuable report.

TIMBER.

AN INVESTIGATION OF ITS CHARACTERISTICS AND PROPERTIES.

Probably comparatively few of the practical railroad men of the country are aware of the extent of the work which has been undertaken by the Forestry Division of the United States Department of Agriculture, under the charge of the able chief of that division, Mr. B. E. Fernow. The results of this work have been given to the public in a series of bulletins, whose value has probably been appreciated by only a few of those who would be most benefited by the wealth of information which these bulletins contain. The conception of this work dates back about ten years, when Mr. Fernow was first appointed to the office he has since held. For several years no investigations were undertaken because the government authorities would not supply the means for equipping a laboratory for making them. In 1890 Prof. J. B. Johnson, of the Washington University in St. Louis, offered to co-operate with the Forestry Division, and those in charge of it were enabled to enter upon the mechanical tests in connection with the physical investigations going on at the laboratory in Washington. Since then the work has progressed by fits and starts, as best it could be forwarded with the limited facilities which were supplied by those who control appropriations for such purposes.

The investigations have been chiefly in relation to Southern timbers owing to the interest taken in that branch of the great subject by Southern railroad companies, and their willingness to carry material to be tested free of charge. Over 20,000 tests of Southern pines were made, and these were so thoroughly carried out that there does not now seem any reason why they need ever be tested again. Another series of tests of hardwoods and cypress have been made which, although not carried out in so extensive a scale as those on the Southern pines, will, nevertheless give a better index of the strength and qualities of these species than has ever been obtained before. These are now being put into form for publication.

The object of this work is not only to give more definite knowledge of the range of strength values of our timber, but more especially to establish rules of inspection which will enable a wood consumer to select his material with knowledge as to its behavior and quality. It will thus be seen that this information will be of immense value to all consumers of wood, and this includes nearly the whole community, but it especially commends itself to railroad companies, who are perhaps the largest consumers of wood in the country.

It is impossible in a short article like this to give anything like a complete idea of the scope of the work which has been laid out. It may be said, in the first place, that to give reliable information concerning the character of any species of timber it is essential to test and examine a large number of specimens of known origin, with information concerning the circumstances of their growth, so as to learn the causes of variation in their properties. It is expected by such a series of investigations to answer some of the following questions:

"What are the essential working properties of our various woods and by what circumstances are they influenced?"

"How does age, rapidity of growth, time of felling and after treatment change quality in different timbers?"

"In what relation does structure stand to quality?"

"How far is weight a criterion of strength?"

"What macroscopic or microscopic aids can be devised for determining quality from physical examination?"

"What difference is there in wood of different parts of the tree?"

"How far do climatic and soil condition influence quality?"

"In what respect does tapping for turpentine affect quality of pine timber?"

A very complete system has been organized for collecting specimens and making the tests, the results of which have been published in the series of bulletins already referred to.

There has been difficulty in persuading the government authorities that this is a class of work which is appropriate for a Government office that is, that it has a sufficient general interest and value to the community to justify the expenditure of public money. As has been pointed out, such an investigation to have the value and scope which it should have, and to accomplish the results aimed at, requires that a very large number of tests be made, with careful consideration of all the attending data. This

necessarily involves considerable expenditure. A bill to appropriate \$40,000 for these tests has been in Congress for several sessions without action. The money expended in making these investigations has been largely derived from the general funds appropriated to the Forestry Division of the Department of Agriculture, but there is now a disposition to abandon the work unless favorable action can be obtained on the bill referred to above. Those interested in the subject—and this includes nearly all engineers, railroad managers, and especially master car builders, architects, etc.—may aid in securing the legislation required to continue the investigation by writing to their Congressman commending the work of the Forestry Division and urging action on the appropriation required to continue and complete the investigation and tests. It would be a public misfortune if these investigations were not continued and if the thorough work of Mr. Fernow was left incomplete.

Notes.

In the April number of the *Stetens Indicator* Mr. Wm. Kent has an article on the heating value of the volatile portion of bituminous coal, in which he urges the need of data obtained from actual tests, and outlines a series of experiments which he thinks would add greatly to the available knowledge on this subject. He then says: Two questions upon which the proposed research may throw some light are: (1) What is the character of the volatile matter of the more highly bituminous coals; and (2) may it not be commercially practicable to get rid of the least valuable portion of [this volatile matter, by some kind of coking process, at the coal mines, and save freight not only upon it, but also on so much of the fixed carbon which is wasted in the ordinary boiler furnace in the operation of distilling the volatile matter? If any of the Western coals containing high percentages of oxygen contain it in such chemical combination that it can be removed at a comparatively low temperature at the coal mine, it would appear that a partial coking of these coals at the mine would be commercially practicable. Even if the oxygen cannot be removed except at a high temperature, it may be found that it carries with it in distillation the valuable by-products which are obtained in the Otto-Hoffman and the Semet-Solvay coking processes, and that their extensive introduction in the West would pay. There is a possibility of fractional distillation of Western coals giving three valuable products, first, gas approximating in composition to natural gas or methane, CH_4 , which could be utilized in factories within a certain distance; second, ammoniacal tar waters, containing valuable substances for use as fertilizers or in the chemical industries; third, smokeless coal or coke, which would be the final solution of the smoke problem in the Western cities.

An official trial has also recently been made of the Belleville boilers constructed by Messrs. Maudsley Sons & Field, at their works in Greenwich, for the new twin screw steamer *Kherson*, built for the Russian volunteer fleet. The following were the conclusions drawn therefrom:

"During the first three hours the evaporation was equal to 9.2 pounds of water per pound of coal burned, and for the first six hours 9 pounds of water. At the end of the sixth hour the fires were cleaned out, and again at the end of the tenth hour, and no allowance was made in the weight of coals. The mean results, it will be seen, are 8.88 pounds of water evaporated per pound of coal, and 21.43 pounds of coal burned per square foot of grate area."

An account of some interesting researches on the value of paints for ironwork, made by Prof. J. Spennrath, has recently been published in the *Deutsches Bauzeitung*. As one result of these, Professor Spennrath concludes that none of the metallic oxides commonly used combine chemically with linseed oil. The drying process depends exclusively on an absorption of oxygen by the oil, which is facilitated by the presence of the pigment in a purely mechanical way. The value of the different pigments used varies. Thus, zinc white, when used for outside work, rapidly swells to double its previous volume, owing to the absorption of carbonic acid gas and water. Sulphuretted hydrogen will cause red or white lead to act in a similar way, but, when pure, Professor Spennrath considers these two latter pigments satisfactory. Carbon paints are very stable, as is heavy spar, but the covering power of the latter is small. In order to test the relative durability of various paints, sheets of zinc were coated with a number of different kinds. The zinc was then dissolved away by acid, leaving a film of paint. All these films, it was found, could be destroyed by the action of dilute nitric or hydrochloric acids, while the vapors of sulphuric and acetic acids acted similarly. Alkaline fluids and gases also destroyed the paints rapidly. Pure water was found to be more injurious than salt water, and hence the destructive action of sea water is to be attributed mainly to the mechanical effects of wash. Hot water was found to act more rapidly than cold. The most important discovery made was, however, the great influence of temperature. Films, similar to those already described, completely lost their elasticity and became brittle when exposed to a temperature of 203 degrees Fahrenheit. There was, at the same time, a large contraction. Similar effects are produced by prolonged exposure to considerably lower temperatures. Blistering he finds to be due to the inner coat

Personal.

Mr. Julian R. Lane has been appointed General Manager of the Macon & Birmingham Railway.

Mr. N. E. Matthews has been appointed Purchasing Agent of the Ohio Southern, vice C. H. Roer.

Mr. John T. Clark has been appointed Master Mechanic of the Northern Ohio, with headquarters at Delphos, O.

Mr. C. H. Barnes has been appointed Division Master Mechanic of the Boston & Albany at West Springfield, Mass.

Mr. Howard James has been appointed Purchasing Agent of the Eastern Railway of Minnesota, with offices at Duluth.

Mr. Alfred Atwood has been appointed Locomotive Superintendent of the Mexican Railway to succeed Mr. E. G. Evens, resigned.

Mr. Wm. H. Taft, for some time past Acting Superintendent of Motive Power of the Boston & Albany, has been appointed Superintendent of Motive Power.

Charles H. Burnett has been appointed Purchasing Agent of the St. Lawrence & Adirondac Railway, with office at No. 51 East Forty-fourth street, New York.

Mr. W. W. Finlay has resigned the Third Vice-Presidency of the Southern Railway, and it is said he will take a position of responsibility on the Great Northern.

Major Edward Leslie, whose name is well-known to railroad men through the rotary snow plow that bears his name, died suddenly at Paterson, N. J., March 26.

During the absence of President Samuel Spencer in Europe, Mr. A. S. Andrews, of Raleigh, N. C., First Vice-president of the Southern Railway, will act as President of the company.

Mr. Thomas B. Purves, Jr., Master Mechanic of the Boston & Albany Railroad, has been appointed Superintendent of Rolling Stock, and will have charge of both the car and locomotive departments. His headquarters are in Boston, Mass.

Mr. David B. Carse, General Manager of Greenlee Bros. & Co., Chicago, manufacturers of wood working machinery, has returned from a three months' trip in Europe, where he visited railroad shops and car works.

Mr. T. D. Kline, who was reported as having accepted the general management of the Inter-oceanic Railway of Mexico, has declined the position, and there is no truth in the report that he is to resign as General Superintendent of the Central of Georgia.

Mr. F. W. Morse, for some years Division Master Mechanic of the Wabash Railroad, with headquarters at Fort Wayne, Ind., has been appointed Superintendent of Motive Power of the Grand Trunk road. He succeeds Mr. Herbert Wallis, who has resigned from that position, which he held since 1873.

Mr. George T. Anderson, late Superintendent of the Indiana Car and Foundry Company, has been appointed Superintendent of the Chicago, New York & Boston Refrigerator Company, vice F. W. Brazier, lately appointed General Foreman of the car department of the Illinois Central. Mr. Anderson has charge of all the line cars, as well as the shops at Fifty-first street, Chicago.

Mr. C. M. Higginson, after many years of service on the Chicago, Burlington & Quincy, has gone to the Atchison, Topeka & Santa Fe as assistant to the President. Mr. Higginson has done much on the Burlington system to establish uniformity and economical co-operation between different departments. He is a civil engineer and has had experience also in the locomotive and accounting departments, and is well fitted in ability and experience to fill the position to which he has been called.

Mr. James S. Drake, General Superintendent of the New Jersey & New York Railroad, died at his home at Hilledale, N. J., on April 16. Mr. Drake began railroad service as apprentice on the Grand Trunk 40 years ago. He was afterward Master Mechanic of the Portland & Rochester road in Maine. Later he occupied a similar position on the New York Elevated Railroad, and in 1879 went to the New Jersey & New York as Master Mechanic. In 1880 he was appointed Superintendent also, and for some years has given all his time to the latter office.

Mr. Robert Miller, General Superintendent of the Michigan Central, is hereafter to be Superintendent of Motive Power and Equipment. Mr. R. H. L'Honnemiedue, former Assistant General Superintendent, becomes Mr. Miller's successor as General Superintendent. Mr. Miller's first position on the Michigan Central road was as Master Car Builder, with charge also of buildings and water-works, which position he occupied for eight years. In 1884 he was transferred to the transportation department, becoming in that year Assistant General Superintendent, and holding the office six years. In taking this new posi-

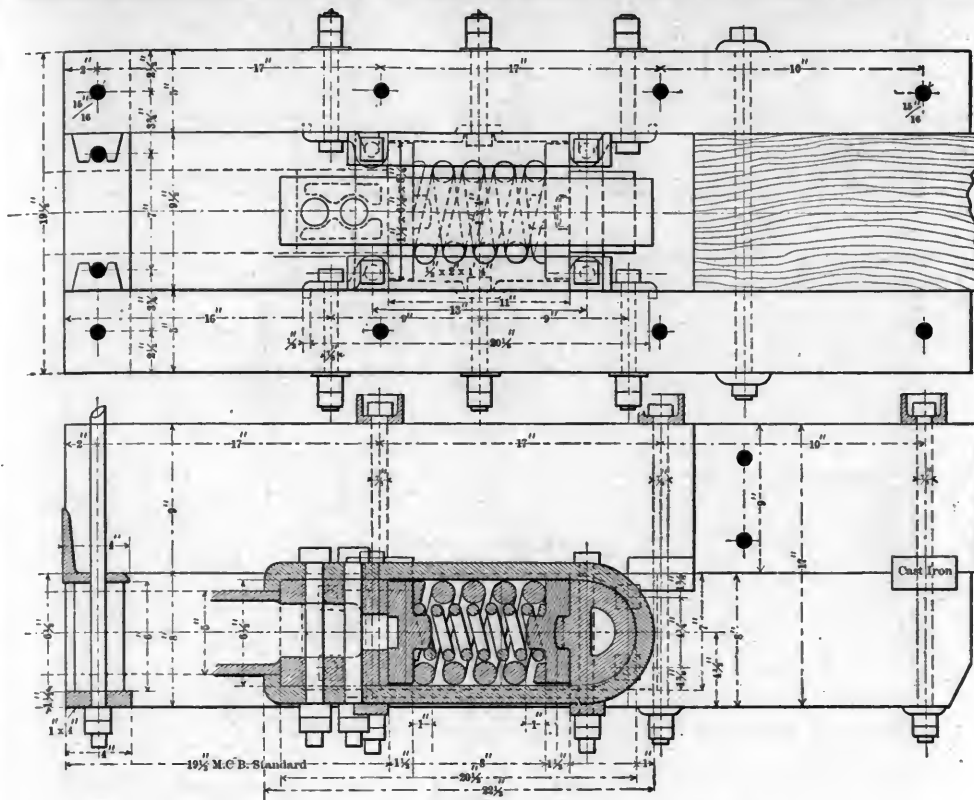


Fig. 3. Draft Rigging for 60,000-Pounds Gondola Car.

der the floor and between the doors, and is free from all danger of sticking. It consists of a toggle which is held down by cams on a shaft carried in the plate shown extending down from the side sill. This shaft is locked by a suitable pawl and gravity dog.

The presence of hoppers makes it impossible to use more than two truss rods, but these two are of liberal dimensions, being 1 1/2 inches in diameter with 1 1/2-inch ends. They have been given a deep camber.

The draft rigging is of the Schoen pressed steel type and is illustrated in Fig. 3. The stops, it will be seen, are in

list of professional papers to be read at this session is as follows:

- KEEP, WILLIAM J.: Strength of Cast Iron.
- KENT, WILLIAM: The Efficiency of a Steam Boiler. What is It?
- ELDRIDGE, A. H.: Tests of a Four-Cylinder Triple-Expansion Engine and Boiler.
- HALE, R. S.: Determining Moisture in Coal.
- KETTEL, CHARLES W.: A Study of the Proper Method of Determining the Strength of Pump Cylinders.
- Goss, W. F. M.: The Effect upon Diagrams of Long Pipe Connections for Steam Engine Indicators.
- CARPENTER, R. C.: A New Form of Calorimeter.
- HOFFMAN, J. D.: A Hydraulic Dynamometer.
- HENDERSON, GEORGE R.: Spring Tables.
- WHITHAM, JAY M.: Effect of Retarders in Fire Tubes of Steam Boilers.
- WHITHAM, JAY M.: Experiments with Mechanical Stokers.
- THURSTON, R. H.: Superheated Steam.
- BRYAN, WILLIAM H.: Western River Steamers.
- ALBERGER, L. R.: A Self-Cooling Condenser.
- PORTER, H. F. J.: Hollow Steel Forgings.
- HUTTON, F. R.: A Classification and Catalogue System for an Engineering Library.
- MURRAY, THOMAS E.: A Steel Plate Fly-Wheel.

The social features of the programme and the excursions planned give promise of much enjoyment and profit.

The National Convention of Railroad Commissioners.

The eighth annual convention of Railroad Commissioners will be held at the office of the Interstate Commerce Commission, No. 1317 F street (Sun Building), in the city of Washington, D. C., on Tuesday, May 19, 1896, at 11 o'clock in the forenoon. The Railroad Commissioners of all States, and State officers charged with any duty in the supervision of railroads, are requested to attend and participate in the discussion of such topics as may come before the convention. The Association of American Railway Accounting Officers is also invited to attend, or send delegates to the convention, and join in the consideration of such questions of special interest to their association as may arise.

At the last convention committees were appointed on the following subjects and directed to report to the next convention:

1. Railway statistics.
2. Uniform classification.
3. Legislation.
4. Protection of public interests during railway labor conflicts.
5. Regulation of State and Interstate electric railways.
6. Powers, duties and actual work accomplished by the several State Railroad Commissions during the year.
7. Government control and government regulation of railways.
8. Safety appliances.
9. Pooling of freights and division of earnings.

The following resolution was adopted at the last meeting: "That a committee of five be appointed to select officers for and subjects to be presented at the next annual convention of this association, to solicit papers upon the same, either from members of the association or from those not connected with the organization, and to prepare, as far as possible, a programme of proceedings; and the following committee on organization and programme for the next convention was named: George M. Woodruff, of Connecticut; G. G. Jordan of Georgia; Ira B. Mills, of Minnesota; E. C. Beddingfield, of North Carolina; Edward A. Moseley, Secretary of the Interstate Commerce Commission.

Members of former conventions are entitled to participate in the discussion of subjects at the coming meeting. The various State Commissions should be represented by full boards, as far as possible, and to that end all Railroad Commissioners are earnestly requested to attend the coming meeting.

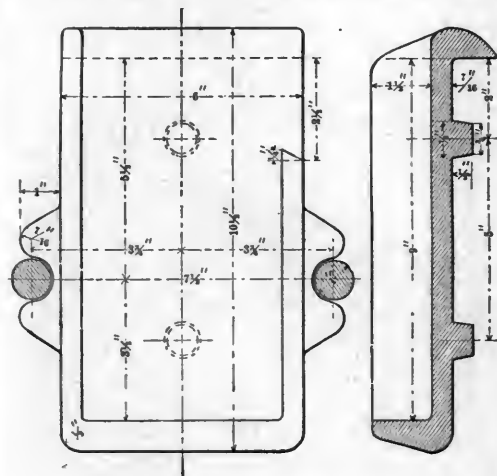


Fig. 2. Pocket Castings.

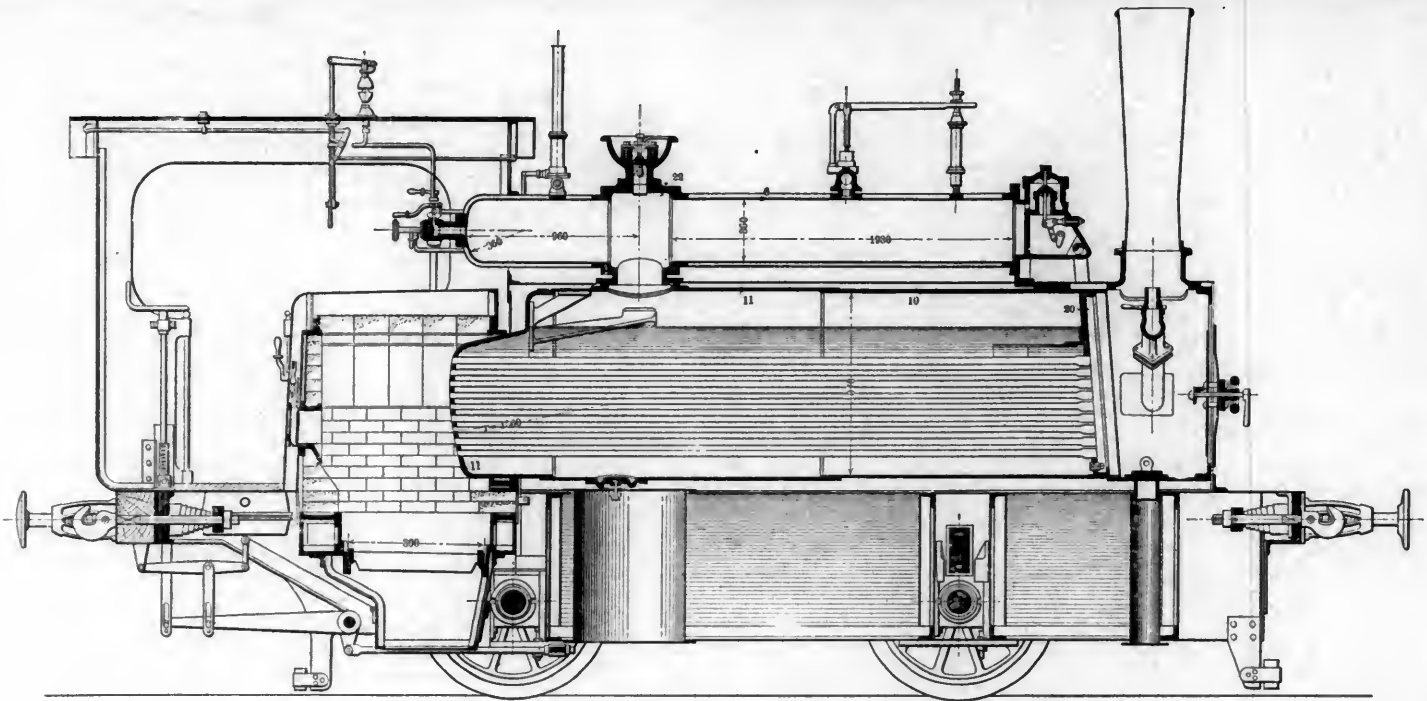
one piece of pressed steel on each timber and are set in at the center and bent over at the ends to mortise into the timber. They are each secured by six bolts. The drawbar strap is Mr. Thompson's design and is made semi-circular at the inner end and a cast-iron block fitted between it and the follower. This makes a stronger strap than the common construction. A 4-inch angle iron is fitted into the face of the end sill to take the impact of the bracket of the coupler.

The body-bolsters are composed of 10-inch by 1-inch top plates and 10-inch by 1 1/2-inch bottom plates. The depth at the center is 6 1/2 inches. The ends of the top plates are bent over the ends of the lower plates, and it will also be seen from the section in Fig. 1 that the truss rod saddle castings are interposed between the ends of the bolsters and the side sills.

The car is carried on Fox pressed steel trucks, air-brakes and M. C. B. type of couplers.

The St. Louis Convention of the American Society of Mechanical Engineers.

The American Society of Mechanical Engineers will hold its semi-annual convention at St. Louis, Mo., May 19 to 23, 1896. The headquarters of the society and its place for holding sessions will be at the Southern Hotel. The



Locomotive With Mason-Work Firebox.—Fig. 1.

tion he therefore returns to a line of work in which he was engaged for years.

Mr. Herbert Wallis has resigned from the position of Mechanical Superintendent of the Grand Trunk, after a service of 23 years in that capacity. Mr. Wallis received his early mechanical training at the Derby shops of the Midland Railway. In 1866 he became foreman in its Bradford shops, and in 1871 accepted the position of Assistant Mechanical Superintendent of the Grand Trunk Railway. In 1873 he was placed at the head of the department. As illustrating the growth of the business since Mr. Wallis has been Mechanical Superintendent, it is stated that the road's locomotive equipment has grown from 353 to 808 engines, its passenger cars from 352 to 916, and its freight car equipment from 6,078 cars to 23,383 cars. Because of tariff restrictions, the road has manufactured many of its supplies that under other conditions would have been purchased, and a large variety of work has therefore been under his care. Mr. Wallis is highly esteemed in railroad and engineering circles. He was recently elected president of the Canadian Society of Civil Engineers.

Mr. Charles E. Smart, General Master Mechanic of the Michigan Central, died at his home in Jackson, Mich., on March 29, after a short illness. Mr. Smart had been General Master Mechanic of the Michigan Central since 1885. He was born at Rochester, N. H., in 1840, and after serving as machinist apprentice in the East, went into the railroad shops at Niles, Mich. In 1860 he went to Vicksburg, Miss., working on the railroad between Vicksburg and Jackson, and shortly afterward went to Cuba in charge of the machinery on a sugar plantation. He returned to the United States, and in 1863 worked for a short time in the Quincy shops of the C., B. & Q. R. R. After another short period spent in Cuba he accepted the position of foreman of the South Bend Iron Works, where he remained until 1872, when he became a locomotive engineer on the Missouri, Iowa & Nebraska road. In 1874 he went to the Michigan Central as a locomotive engineer, and a year later became Master Mechanic of the Mackinaw Division in charge of the locomotive and car departments. That office he held for 10 years, when he became General Master Mechanic of the road.

The Butler & Pittsburg Railway Company was organized in the offices of the Carnegie Steel Company April 24th. J. T. O'Dell, of Boston, was chosen President. Andrew Carnegie and T. M. Carnegie, Jr., are directors. The Secretary is authorized to at once advertise for bids for construction of track and road bed. When completed the new road will be merged into the Pittsburgh, Shenango & Lake Erie Railroad. The Carnegie Steel Company guarantees the road at least three million tons of ore a year.

The contract for building the new passenger station at Providence, R. I., together with the office and express buildings on either side of the station, has been let to Hortons & Hemmenway, of Providence, for \$425,000. The contractors expect to begin work immediately, and are under obligation to have the buildings under roof by Jan. 1. The basements of the three structures will be built of Lee's Island granite, and the walls will be of buff brick with sandstone trimmings. The floors of the waiting-rooms and corridors will be marble in mosaic patterns, and the woodwork will be of quartered oak. The inside walls will be of enameled tile.

Locomotive Boiler with Mason-Work Firebox.*

BY A. SOCHER, CHIEF ENGINEER OF THE ROYAL AUSTRIAN STATE RAILWAY IN LARABACH.

In designing the locomotive boiler illustrated by Figs. 1 and 2, the first and main object that was kept constantly in view was to obtain the greatest possible safety against explosion.

That the boiler with a stayed firebox, built upon the Stephenson designs, is only partially satisfactory in this respect will be readily acknowledged. Even if the locomotive boiler does not occupy a prominent place in the statistics of boiler explosions, it is simply that we have the conditions under which it works to thank, for railroad officials exercise the most painstaking oversight and most careful inspection in connection with their boilers as being a matter of the utmost importance to themselves. In spite of this, however, bad water, sulphurous coal, etc., give many unpleasant surprises to boiler inspectors. Hence, there is no doubt but that there is an actual and pressing necessity for a safer construction of locomotive boilers.

Noteworthy efforts have been made of late years in this direction without as yet having fully satisfied all of the conditions of this exceedingly difficult problem. The reason for this may lie in the fact that the designs which have been brought out follow too closely the common type of boiler, by which a comparatively satisfactory reconstruction of the existing boiler becomes possible, but it will be confined between limits that are cramped and well defined as to the form which it shall assume.

From the following description it will be seen whether, or to what extent, this boiler is an improvement in form over the one that has just been denounced, and which is the prevailing type of the day.

The construction of locomotive No. 822 of the Royal Austrian State Railway was completed and the engine put into service in April, 1894.

The construction of the boiler is exceedingly simple. The shell or barrel of the boiler ending in a smokebox, and the front tubesheet, are worthy of no particular attention. The stayed portion of the boiler has been entirely discarded. In its stead a cone-shaped drum is used that projects into the furnace, into the front side of which the tubes open. This drum is placed, so far as the products of combustion are concerned, entirely below the water level. The bottom line of the cone-shaped projection is straight, while at the top it curves over the double angle of the cone.

A straight steam collecting drum or tube is used instead of a steam drum, into which the steam flows through a hollow connection that is placed above the point where the most rapid generation takes place. At the back end there are the cab connections, on top are the safety valves, while the throttle is placed at the front.

To this peculiar boiler the masonry firebox is added. This is closed at the top by a semicircular arch, which encloses the tubesheet drum already described. The arch rests upon brackets on either side and is independent of the remaining portion of the brickwork, which is locked to the sides of the firebox by special plates. The brickwork of the side and back walls of the firebox rest upon a cast iron frame that has an opening on the inside which is closed against the fire itself by iron plates. At the front end, two rows of bricks project out far enough to protect the bottom of the tubesheet drum from the direct action of the impinging flames.

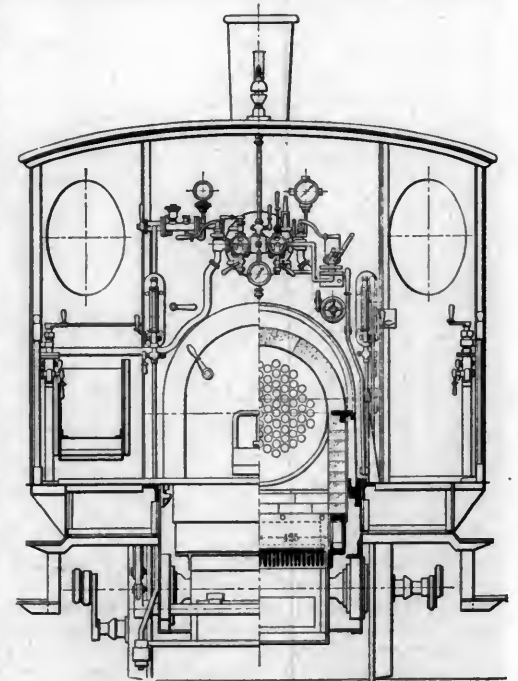
The back wall rests upon a rectangular iron frame, and is closed by a sliding door whose vertical motion is controlled by a movable guide, both guide and slide being balanced by a counterweight. There is nothing novel in the arrangement of the grates, ashpan, claspers and the sheet-iron casing over the firebox.

The expansion of the boiler has no effect upon the firebox since the latter is not connected to the shell, but is fastened

by itself upon its own frame. This arrangement has given no trouble at all.

The boiler was built at the machine shops of the Alpine Mountain Company (*Alpinen Montangesellschaft*) at Klagenfurt in 1893. The sheets are made of Martin basic steel from the Herkust Works in Styria.

The two portions of the barrel are each riveted on the longitudinal seam, and the same is done with both portions of the steam drum; the shaped piece on the latter consisting of crucible cast steel. The mean inside diameter of the barrel is 3 feet 6.91 inches, with a thickness of .43 inch. The front tube sheet has a thickness of .79 inch and the back .43 inch; into these there are placed 99 rolled Mannesmann tubes, having an inside diameter of 1.61 inches, and an outside diameter of 1.81 inches, with an average length of 12 feet 1.27 inches between the tube sheets. These are expanded into



Locomotive With Mason-Work Firebox.—Fig. 2.

place in the usual manner with copper ferrules. The heating surface of the tubes thus amounts to 505.9 square feet and the total heating surface, including that portion of the tubesheet drum that is subjected to the direct action of the flames, amounts to 518.6 square feet. The steam pressure is 12 atmospheres (180 pounds per square inch). The boiler was built into the locomotive No. 822, that has a tender, under the direction of the designers. The principal dimensions as compared with those of an ordinary boiler are as follows:

	Boiler.	New.	Ordinary.
Diameter of barrel.....	3 feet 6.91 inches	3 feet 6.91 inches	3 feet 6.91 inches
Number of tubes.....	99	99	99
Diameter of tubes outside.....	1.81 inches	1.81 inches	2.29 inches
" " inside.....	1.61 "	1.61 "	1.61 "
Length " ".....	12 feet 1.27 "	12 feet 1.27 "	10 feet 3.92 "
Heating surface in tubes.....	505.9 square feet	505.9 square feet	481.4 square feet
Total heating surface.....	518.6	518.6	525.3
Steam pressure.....	120 pounds	120 pounds	120 pounds

After a number of tests both with and without loads, in all of which satisfactory results were obtained, the locomotive was placed in regular service in April, 1894, and ran along with six sister locomotives doing the same work.

* Translated from the *Organ für die Fortschritte des Eisenbahnwesens*.

remote from the designer so that he could not possibly have exerted any influence upon the results obtained in this service work.

After a service of seven months the locomotive was sent to the main shops at Knittelfeld, in order that a thorough inspection of the outside and inside of the boiler might be made for the purpose of ascertaining whether it had experienced any injury.

After the steam drum had been removed it was possible to enter the boiler and inspect it to the remotest corner without removing the tubes.

The sheets of the boiler, including the tubesheet drum, showed an even coating of scale over the whole surface to a thickness of about .04 inch, and this extended up to about the top of the average water line.

Since the coating of scale showed small cracks, and as there were none at the angles where the three stays connected, it is safe to conclude that the boiler was subjected to a slight change of form that was detrimental to it.

In the steam drum two flange bolts were broken; the reason being that the front end of the tube was bolted solidly to the throttle chamber. Later measurements showed that the drum had expanded by the heat 2 inches more than the corresponding portion of the boiler between the two points of attachment. After making an allowance for the necessary play, the locomotive was put back into service without any improvement being made in the boiler. In the brickwork of the firebox no improvement was necessary. A partial change was first made after it had been in service for 13 months. According to the results of the service as given in a report of a year's work in comparison with the sister locomotives we have the following:

Locomotive.	New.	Total of six ordinary.
Mileage.....	25,405	149,535
Gross loads hauled.....	1,907,990 tons	11,235,655 tons
Consumption of coal per mile.....	31.6 pounds	35.76 pounds
Consumption of coal per 1,000 gross ton miles.....	678.0	786.00

This shows a saving in coal consumption in favor of experimental boiler, both in locomotive mileage and 1,000 ton miles, of about 11½ per cent.

This saving is not an inconsiderable matter in itself, but it should also be taken into consideration that this was obtained almost entirely with a low-priced brown coal whose theoretical calorific power only amounted to 12,220 heat units, which of itself was not at all favorable to a better showing.

OBSERVATIONS IN SERVICE.

The generation of steam from a perfectly cold boiler required, as was anticipated, from a half to three-quarters of an hour more time than with the ordinary boiler, while, on the other hand, after being housed it would retain its pressure for twelve hours, so that during this period the locomotive could be placed under a full head of steam in a few minutes.

The generation of steam is rapid and the water level can be kept at a high point while the boiler is being forced to the utmost. That this is the case is proven by the fact that investigation showed from the water line indicated on the inside of the boiler that it had been run with the glass entirely filled. In this connection there is the very remarkable fact to be borne in mind that there was never any water carried over into the cylinders.

The arrangement of the steam drum must be considered as a fortunate one and one tending to collect steam that is dry. The application of this form of construction to the ordinary locomotive boiler instead of the uncumely and wide opening in the barrel for the dangerous vertical steam dome, is therefore certainly worthy of consideration.

The tubes are of the ordinary thickness, but an application of a thicker tube for staying purposes to the outer circle could be made to advantage. The belled form of the tubesheet cannot be recommended for further application because the expanding of the tubes, especially those farthest from the center, is rendered difficult, and they are troublesome to keep tight except by constant calking.

On sultry summer days the radiation of heat from the firebox, especially from the back, was very oppressive. This difficulty was effectively met by the introduction of a brisk current of air in between the brickwork and the casing, but coupled with a loss of heat that was not an insignificant one.

The manner in which, upon a further application of this new form of boiler, the radiation is to be checked as much as possible, while, at the same time, the action of the fire is to be increased, will be developed in a future communication.

The many promising results that have been obtained with this new form of boiler on the experimental locomotive have induced the management of the Royal Austrian State Railway to build a similar boiler for a special locomotive and also a larger one for a locomotive of series No. 88.

The first, which will be a six-wheel coupled passenger engine, will soon be built and is already well on its way toward completion.

It is clearly to be seen that the steam-producing efficiency of the perfectly water-cooled firebox will be raised by the increased evaporation induced by the greater length of tubes obtained by lengthening the tubesheet drum. The considerably higher temperature of the products of combustion at the start, due to the conditions under which the fire burns in this box lined with firebrick, requires that the tubes should be slightly longer in order that the temperature of the gases entering the smokebox shall not be too high.

It has been thoroughly well established by experiment that in the Stephenson type of boiler there is no advantage in using tubes longer than 15 feet 9 inches, as far as steam production is concerned.

With this new form of boiler this length, which is the greatest that is efficient at present, may be increased, and with it comes the possibility that locomotives, like those having eight wheels coupled, for example, which up to the present time carry a useless weight of long tubes in their boilers, may be equipped with boilers that are considerably

more efficient as steam producers. Furthermore, the new boiler is particularly well adapted for use on locomotives where bad feed water must be used, and where coal that contains a high percentage of sulphur must be burned. Finally, the new boiler can well be used on construction locomotives, since these are, for the most part, in the hands of careless men.

Third Annual Convention of the Association of Railroad Air-Brake Men.

(Concluded from Page 76.)

In the discussion the drain cup received a good share of attention, and a number of members found the only satisfactory way to clean it was to take it down entirely and remove the dirt either with steam or a lye bath. Mr. Farmer spoke on the defect card and advocated its use, as where brakes could not be repaired at the station where the defects were first noted, either from lack of time or facilities, the card would be a notification to parties further along the line to make the needed repairs. Mr. Fraser said that on the Southern Pacific they used blanks for reporting not only brake defects but also hot boxes and drawbars pulled out. Mr. Saunders said that on the Pennsylvania road blanks were used for reporting by inspectors and conductors. Both had to report and their reports were compared, and if they did not agree the man who failed to note a defect had to explain. Mr. Hawks, of the C. & A. Railway gave an interesting talk on maintenance, in the course of which he said that he had worked for the Alton over 40 years, and that he used to have a leather bag that contained all the tools he needed for repairs. Now, we must have test yards, racks, and many tools and appliances. Since he began his career in air-brake work, such advances have been made that now he has the sixth kind of triple, the sixth pump and the third kind of hose. He used cards and blank reports that are filled out and sent to him. The chairman, Mr. Brodnax, gave the results of some experiments in transmission of air through three-quarter-inch pipe half a mile long, with the idea of saving expense where the air had to be carried a long distance.

On the third day of the convention the report on "Main Reservoir and Connections" was read. The report is largely devoted to the location of the reservoir and to its volume. The location preferred is back of the cylinder saddle, between the frames. The other possible locations are under the moving board and under the foot plate. It should never be located on the tender if it is possible to avoid it. A large main reservoir is advocated for the following reasons:

- 1st. Less delay in getting train charged for testing.
- 2d. Increased safety through ability to quickly release and recharge after any application, whether for stops, holding down grades, terminal tests, break in two, bursted hose or emergency application caused by engineer or trainmen.
- 3d. Increased life of air-hose and air-pump, combined with greater efficiency of the latter, and also decreased wear and better performance of engineer's brake valve.
- 4th. Less liability for triple valve to delay in releasing, and consequently wheels to slide.
- 5th. Less moisture in triple valves and consequent freezing up in winter.

For reasons given in the foregoing the committee recommended:

- 1st. That the capacity of main reservoirs be made greater than now generally employed. Sixteen thousand cubic inches or over for passengers, and 20,000 cubic inches or over for freight.
- 2d. That where practicable, they be placed on engines and not on tender.
- 3d. That the air inlet and outlet be separated as far as possible, and the outlet be at the top of the reservoir.
- 4th. That but two connections to the main reservoir be made.
- 5th. That where possible, the pipes leading from pump to reservoir have a gradual incline for drainage toward the latter.

This report was not discussed at any great length and the one that followed, on "Train Signals," was not in type, but was read from the manuscript, and the members therefore were not able to discuss it.

The reports of committees having been disposed of, the remainder of the session was devoted to topical discussions and to election of officers, etc. Nashville was chosen as the place of meeting for 1897. The officers elected were as follows: President, S. D. Hutchins; First Vice-President, A. J. Cota; Second Vice-President, C. P. Cass; Third Vice-President, W. F. Brodnax; Secretary, P. M. Kilroy; Treasurer, Otto Best. Resolutions of thanks were passed to those who had extended courtesies to the association, including railroads that had furnished help to committees by giving them the facilities for carrying out experiments.

Experiments have, according to the *Improvement Bulletin*, recently been made by Mr. A. W. Haacke respecting the amount of heat lost by radiation through steam pipes. The tests were directed to determine the relative losses of heat from, first, bare pipes; second, pipes covered with 1 inch of insulating composition; and third, pipes covered with 1 inch of insulating composition and three layers of hair felt. The testing surfaces consisted of three cast-iron steam pipes of 5-inch external diameter, and 6 feet long, with blank flanges on each end. The pipes were supplied by steam that had been dried and so placed as to be subject to radiation and conduction under precisely similar conditions, one being bare and two others covered, as before mentioned. The results of the experiment are quite interesting. With steam at a pressure of from 45 pounds to 60 pounds, out of a possible loss of 100 per cent., as much as 83 per cent. is saved by a 1-inch covering of composition. If over this covering 1 inch and 1½ inches of hair felt with canvas is added, the extra saving is only 8½ per cent. If 1 pound of coal is required to evaporate 8 pounds of water into steam at 60 pounds pressure, then every square foot of uncovered steam-pipe wastes 6½ hundredweight of coal per year. At a higher pressure of steam, and in cold weather, this loss is even greater.

The Most Advantageous Dimensions for Locomotive Exhaust Pipes and Smoke Stacks.*

BY INSPECTOR TROSKER.
(Continued from page 47.)

G. COMPARISON OF THE DIFFERENT FORMS OF STACKS.

If we bring together the three forms of stacks that have been considered, their own diameters and that of their nozzles being the same, what has been said will be made clear. A reference to Plate II. and the related Table VII. brings this out.

The tables are full of information in many ways: First they show the slight rise in the course of the curves of cylindrical stacks over those of the conical, from which it again appears that those of the greatest flare have the highest curves. Up to a certain nozzle distance and with certain stack diameters the curves of the cylindrical stacks are the highest, while those with an inclination of one in six are the lowest, and those of the one in twelve stacks are between the two; then the first curve falls below that of the one in twelve stack, which also by a still further increase of the nozzle distance finally falls below that of the one in six stack. The larger the stack and the smaller the nozzle opening, just so much more striking do these differences become.

The tables belonging to Plate VII. give some information regarding this noteworthy phenomena. They include the nozzle distances corresponding to three forms of stacks which have produced the highest vacuums with the five nozzles. These distances are here calculated from the bottom of the stack in order to keep the figures smaller. We next see that the maximum is reached considerably earlier with the cylindrical stack than it is with the conical, and in these latter again the less they flare open at the top. The two conical forms of stack can furthermore develop the same maximum if the nozzle distance is correspondingly adjusted. In stacks with the smallest diameters of 14.76 inches for example a vacuum of 4.13 inches can be obtained with a nozzle diameter of 3.94 inches for the one in twelve stacks the nozzle distance from the bottom of the stack must be 1 foot 9.85 inches, for the one in six stacks this nozzle distance must be 2 feet 2.97 inches. In the same way with a cylindrical stack of 14.76 inches diameter we get a vacuum of only 0.2 inch less with a nozzle distance, measured from the bottom of the stack of 13.98 inches.

We see, further, from Table XIV., that the necessary nozzle distance for obtaining the highest vacuum with all forms of stacks increases the smaller the nozzle diameter

TABLE VII.—SHORTENED STACKS.

A.—Cylindrical Stacks.

1.—Stack Diameter = 14.76 inches.

Length of stack.	Nozzle Diameters in inches.				
	3.94	4.33	4.74	5.12	5.51
Full length.....	Beginning..... 3.76	1.04	4.37	4.65	4.45
	Maximum..... 3.94	4.33	4.74	5.12	5.51
Shortened 11.81 inches.....	Beginning..... 3.11	3.43	3.74	3.86	3.92
	Maximum..... 3.74	4.02	4.33	4.34	4.29
" 1 foot 8.87 inches.....	Beginning..... 2.62	2.81	3.11	3.27	3.41
	Maximum..... 3.56	3.89	4.10	4.13	4.13
" 2 feet 3.56 inches.....	Beginning..... 1.37	1.85	2.19	2.36	2.62
	Maximum..... 3.35	3.59	3.57	3.94	3.83
Total fall in the vacuum for the beginnings.....	2.13	2.19	2.24	2.09	1.98

2.—Stack Diameter = 15.75 inches.

Length of stack.	Nozzle Diameters in inches.				
	3.94	4.33	4.74	5.12	5.51
Full length.....	Beginning..... 3.43	3.76	4.09	4.23	4.29
	Maximum..... 3.74	4.06	4.37	4.51	4.45
Shortened 11.81 inches.....	Beginning..... 2.82	3.11	3.43	3.63	3.74
	Maximum..... 3.56	3.89	4.10	4.13	4.13
" 1 foot 8.87 inches.....	Beginning..... 2.20	2.48	2.78	3.02	3.19
	Maximum..... 3.44	3.74	4.03	4.13	4.02
" 2 feet 3.56 inches.....	Beginning..... 1.34	1.61	1.89	2.11	2.32
	Maximum..... 3.25	3.54	3.84	3.94	3.83
Total fall in the vacuum for the beginnings.....	2.09	2.15	2.20	2.12	1.87

NOTE.—The figures give the vacuum in inches of water at the beginning with a nozzle position of 1 ft. 6.9 in., and the maximum values obtained, whose corresponding nozzle location varies with the diameter of the stack.

3.—Stack Diameter = 16.73 inches.

Length of Stack.	Nozzle diameters in inches.				
	3.94	4.33	4.74	5.12	5.51
Full length.....	Beginning..... 3.11	3.45	3.78	3.94	4.04
	Maximum..... 3.50	3.84	4.13	4.29	4.33
Shortened 11.81 inches.....	Beginning..... 2.48	2.80	3.11	3.30	3.43
	Maximum..... 3.39	3.70	3.96	4.09	4.13
" 1 foot 8.87 inches.....	Beginning..... 1.89	2.17	2.46	2.68	2.83
	Maximum..... 3.27	3.52	3.79	3.96	3.94
" 2 feet 3.56 inches.....	Beginning..... 1.06	1.34	1.61	1.85	2.05
	Maximum..... 3.03	3.37	3.68	3.80	3.80
Total fall in the vacuum for the beginnings.....	2.05	2.11	2.17	2.09	1.90

4.—Stack Diameter = 17.72 inches.

Length of Stack.	Nozzle diameters in inches.				
	3.94	4.33	4.74	5.12	5.51
Full length.....	Beginning..... 2.80	3.11	3.45	3.62	3.74
	Maximum..... 3.25	3.56	3.90	4.06	4.09
Shortened 11.81 inches.....	Beginning..... 2.17	2.46	2.78	2.97	3.11
	Maximum..... 3.17	3.50	3.82	4.00	4.06
" 1 foot 8.87 inches.....	Beginning..... 1.57	1.83	2.11	2.32	2.46
	Maximum..... 3.05	3.39	3.72	3.90	3.98
" 2 feet 3.56 inches.....	Beginning..... 0.85	1.04	1.26	1.46	1.63
	Maximum..... 2.83	3.17	3.50	3.68	3.82
Total fall in the vacuum for the beginnings.....	1.85	2.07	2.19	2.16	2.11

* Paper read before the German Society of Mechanical Engineers, and published in *Glaciers Annalen für Gewerbe und Bauwesen*.

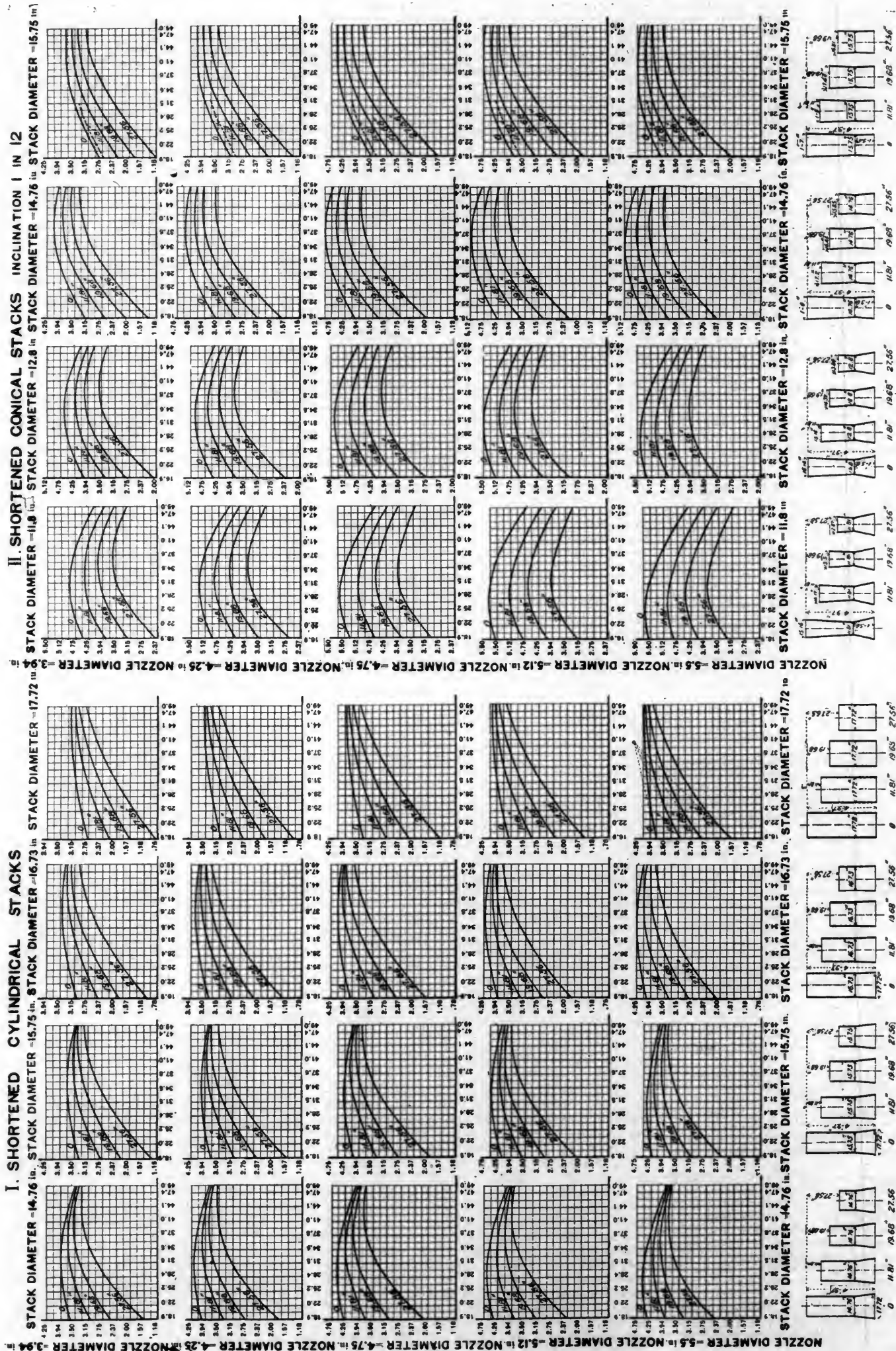


PLATE III.—DETAIL DIAGRAMS OF THE HANOVER SMOKESTACK AND EXHAUST NOZZLE EXPERIMENTS.

TABLE VIII. B.—CONICAL STACKS WITH AN INCLINATION OF 1 IN 12.

1.—Stack Diameter = 11.81 inches.

Length of stack.		Nozzle diameters in inches.				
		3.94	4.33	4.74	5.12	5.51
Full length.....	Beginning.....	4.49	4.92	5.35	5.78	6.21
	Maximum.....	4.90	5.29	5.65	6.01	6.37
Shortened 11.81 inches.....	Beginning.....	3.86	4.23	4.63	5.02	5.41
	Maximum.....	4.29	4.66	5.02	5.38	5.74
" 1 foot 8.87 inches.....	Beginning.....	3.23	3.58	3.94	4.31	4.67
	Maximum.....	3.64	4.01	4.37	4.74	5.10
" 2 feet 3.56 inches.....	Beginning.....	2.60	2.95	3.31	3.67	4.03
	Maximum.....	3.01	3.36	3.72	4.08	4.44
Total fall in the vacuum for the beginnings.		2.09	2.20	2.32	2.44	2.56

2.—Stack diameter = 12.8 inches.

Length of stack.		Nozzle diameters in inches.				
		3.94	4.33	4.74	5.12	5.51
Full length.....	Beginning.....	4.08	4.49	4.90	5.31	5.72
	Maximum.....	4.49	4.90	5.31	5.72	6.13
Shortened 11.81 inches.....	Beginning.....	3.46	3.84	4.23	4.63	5.02
	Maximum.....	3.87	4.23	4.63	5.02	5.41
" 1 foot 8.87 inches.....	Beginning.....	2.85	3.19	3.58	3.94	4.31
	Maximum.....	3.26	3.61	3.97	4.33	4.69
" 2 feet 3.56 inches.....	Beginning.....	1.81	2.14	2.49	2.85	3.21
	Maximum.....	2.22	2.54	2.90	3.26	3.62
Total fall in the vacuum for the beginnings.		2.01	2.09	2.18	2.27	2.36

3.—Stack diameter = 14.76 inches.

Length of stack.		Nozzle diameter in inches.				
		3.94	4.33	4.74	5.12	5.51
Full length.....	Beginning.....	4.25	4.66	5.07	5.48	5.89
	Maximum.....	4.66	5.07	5.48	5.89	6.30
Shortened 11.81 inches.....	Beginning.....	3.63	4.01	4.41	4.81	5.21
	Maximum.....	4.04	4.41	4.81	5.21	5.62
" 1 foot 8.87 inches.....	Beginning.....	3.02	3.39	3.79	4.19	4.59
	Maximum.....	3.43	3.80	4.19	4.59	4.99
" 2 feet 3.56 inches.....	Beginning.....	2.41	2.77	3.17	3.57	3.97
	Maximum.....	2.82	3.18	3.58	3.98	4.38
Total fall in the vacuum for the beginnings.		1.83	1.93	2.07	2.11	2.05

4.—Stack diameter = 15.75 inches.

Length of stack.		Nozzle diameter in inches.				
		3.94	4.33	4.74	5.12	5.51
Full length.....	Beginning.....	4.42	4.83	5.24	5.65	6.06
	Maximum.....	4.83	5.24	5.65	6.06	6.47
Shortened 11.81 inches.....	Beginning.....	3.80	4.19	4.59	4.99	5.39
	Maximum.....	4.21	4.60	5.00	5.40	5.80
" 1 foot 8.87 inches.....	Beginning.....	3.19	3.58	3.98	4.38	4.78
	Maximum.....	3.60	3.99	4.39	4.79	5.19
" 2 feet 3.56 inches.....	Beginning.....	2.58	2.97	3.37	3.77	4.17
	Maximum.....	2.99	3.38	3.78	4.18	4.58
Total fall in the vacuum for the beginnings.		1.64	1.75	1.93	1.99	1.93

TABLE IX. C.—CONICAL STACKS WITH AN INCLINATION OF 1 IN 6.

1.—Stack Diameter = 11.81 inches.

Length of Stack.		Nozzle diameter in inches.				
		3.94	4.33	4.74	5.12	5.51
Full length.....	Beginning.....	3.84	4.31	4.88	5.45	6.02
	Maximum.....	4.25	4.72	5.29	5.86	6.43
Shortened 11.81 inches.....	Beginning.....	3.20	3.74	4.23	4.74	5.25
	Maximum.....	3.61	4.15	4.63	5.14	5.65
" 1 foot 8.87 inches.....	Beginning.....	2.56	3.05	3.53	4.04	4.55
	Maximum.....	2.97	3.46	3.94	4.45	4.96
" 2 feet 3.56 inches.....	Beginning.....	1.95	2.41	2.87	3.34	3.81
	Maximum.....	2.36	2.82	3.28	3.75	4.22
Total fall in the vacuum for the beginnings.		1.67	1.81	2.01	2.07	2.09

2.—Stack Diameter = 12.8 inches.

Length of Stack.		Nozzle diameter in inches.				
		3.94	4.33	4.74	5.12	5.51
Full length.....	Beginning.....	3.84	4.31	4.88	5.45	6.02
	Maximum.....	4.25	4.72	5.29	5.86	6.43
Shortened 11.81 inches.....	Beginning.....	3.20	3.74	4.23	4.74	5.25
	Maximum.....	3.61	4.15	4.63	5.14	5.65
" 1 foot 8.87 inches.....	Beginning.....	2.56	3.05	3.53	4.04	4.55
	Maximum.....	2.97	3.46	3.94	4.45	4.96
" 2 feet 3.56 inches.....	Beginning.....	1.95	2.41	2.87	3.34	3.81
	Maximum.....	2.36	2.82	3.28	3.75	4.22
Total fall in the vacuum for the beginnings.		1.64	1.75	1.93	1.99	1.93

3.—Stack Diameter = 14.76 inches.

Length of stack.		Nozzle diameter in inches.				
		3.94	4.33	4.74	5.12	5.51
Full length.....	Beginning.....	4.25	4.66	5.07	5.48	5.89
	Maximum.....	4.66	5.07	5.48	5.89	6.30
Shortened 11.81 inches.....	Beginning.....	3.63	4.01	4.41	4.81	5.21
	Maximum.....	4.04	4.41	4.81	5.21	5.62
" 1 foot 8.87 inches.....	Beginning.....	3.02	3.39	3.79	4.19	4.59
	Maximum.....	3.43	3.80	4.19	4.59	4.99
" 2 feet 3.56 inches.....	Beginning.....	2.41	2.77	3.17	3.57	3.97
	Maximum.....	2.82	3.18	3.58	3.98	4.38
Total fall in the vacuum for the beginnings.		1.40	1.51	1.64	1.73	1.76

4.—Stack Diameter = 15.75 inches.

Length of Stack.		Nozzle diameter in inches.				
		3.94	4.33	4.74	5.12	5.51
Full length.....	Beginning.....	4.42	4.83	5.24	5.65	6.06
	Maximum.....	4.83	5.24	5.65	6.06	6.47
Shortened 11.81 inches.....	Beginning.....	3.80	4.19	4.59	4.99	5.39
	Maximum.....	4.21	4.60	5.00	5.40	5.80
" 1 foot 8.87 inches.....	Beginning.....	3.19	3.58	3.98	4.38	4.78
	Maximum.....	3.60	3.99	4.39	4.79	5.19
" 2 feet 3.56 inches.....	Beginning.....	2.58	2.97	3.37	3.77	4.17
	Maximum.....	2.99	3.38	3.78	4.18	4.58
Total fall in the vacuum for the beginnings.		1.19	1.30	1.41	1.52	1.54

the steam pressure remaining the same. Thus, for example, suppose the nozzle diameter drops from 5.51 inches to 3.94 inches the amount of steam delivered falls to about one-half and the nozzle distance, measured from the bottom of the stack, with a diameter of 14.76 inches, increases as follows:

Cylindrical stack from 10.04 inches to 13.98 inches.	17.92	21.83
One in twelve " " " "	23.45	26.97

Thus, in all three cases the variation is about the same, or 3.94 inches. This increase of the nozzle position shows that, according to Section VIII., the stream of steam issuing from a small nozzle under otherwise equal conditions forms a smaller cone than that issuing from a larger one, so that with the same location of the nozzle the full section of the stack is filled later, which means that it is filled at a greater distance from the nozzle opening. Finally, Table VII. also shows that, with the nozzle in the same position and within the limits recommended above for practical work, the

cylindrical stack produces the highest vacuum, its diameter being equal to that of the waist of the others, yet with the sharpest taper, as well as with the least, the vacuum produced can be equalized, provided that the nozzle diameter is properly proportioned to the stack diameter.

IV.—EXPERIMENTS IN THE SHORTENED STACKS.

The experiments with the 15 stacks heretofore discussed were now extended, so that the whole series was repeated with stacks shortened an equal amount, as follows:

1. By a shortening of 11.42 inches.
2. By additional shortening of 7.57 inches. Total, 17.16 inches.
3. By additional shortening of 7.57 inches.

All of the shortened stacks were tested with the nozzles under the same conditions as before. The results obtained for each of the three forms of stack are given in Table X. and XI., and for the two nozzle positions in the accompanying Tables VII. to IX.

As a first result of the shortening of the stack there was a very noticeable diminution of the vacuum produced. This reduction was not in an exact ratio to the amount of shortening, but was somewhat greater, as will be seen from Table X.

For each inch of shortening in the above table the vacuum falls about as given in Table XI.

We see that this fall in the vacuum is considerably more for the cylindrical stacks than it is for the conical ones; and for the latter the loss is the greater as the opening at the top is narrower.

Thus we find a skillfully demonstrated refutation of the proposition erroneously stated by Zenner, that the height of the stack has a very subordinate influence upon the action of the blast nozzle.

This is shown still more clearly in Fig. 36. It gives the fall in the vacuum, with cylindrical stacks having a diameter of 17.72 inches and an original length of 7 feet 4.6 inches, or five times the diameter, that are gradually shortened to nothing. The three curves show the vacuums produced with nozzle openings of 3.94 inches, 4.74 inches and 5.51 inches. Their co-ordinates were obtained on the experimental apparatus under the same conditions as the rest of the data.

TABLE X.

Exhaust Nozzle Diameter.	Reduction of vacuum in inches as the result of a further shortening of the cylindrical and conical stacks by 15.75 inches, with a nozzle location of 18.9 inches below the bottom of the same.								
	Shortened 11.81 in.			Shortened 19.68 in.			Shortened 27.56 in.		
	Inches.	Cyl.	Con.	Inches.	Cyl.	Con.	Inches.	Cyl.	Con.
3.94	0.61	0.51	0.37	1.22	1.00	0.75	2.09	1.63	1.18
4.33	0.65	0.53	0.41	1.28	1.06	0.81	2.15	1.75	1.30
4.74	0.67	0.50	0.45	1.32	1.18	0.89	2.20	1.93	1.42
5.12	0.61	0.51	0.49	1.22	1.22	0.96	2.13	1.98	1.52
5.51	0.55	0.51	0.51	1.10	1.29	0.98	1.97	1.97	1.54

TABLE XI.

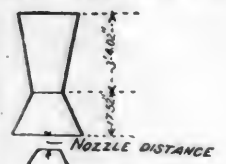
Total Shortening.	Cylindrical.	Conical, 1/12.	Conical, 1/6.
11.81 inches.	0.0523 inch.	0.0183 inch.	0.0378 inch.
19.68 "	0.0624 "	0.0385 "	0.0416 "
27.56 "	0.0765 "	0.0672 "	0.0517 "

TABLE XIV.—COMPARISON OF THE HIGHEST INDICATED VACUUM AND THE CORRESPONDING DISTANCES OF THE EXHAUST NOZZLES FROM THE LOWER ENDS OF STACKS OF EQUAL DIAMETERS.

(a) Full Length Stacks.

Stacks.		Exhaust Nozzle Diameters.									
		3.94 in.		4.33 in.		4.74 in.		5.12 in.		5.51 in.	
Diam.	Shape.	Vacuum.	Nozzle Location.	Vacuum.	Nozzle Location.	Vacuum.	Nozzle Location.	Vacuum.	Nozzle Location.	Vacuum.	Nozzle Location.
13.78	Cylindrical.	4.04	8.86	4.29	8.47	4.59	6.89	4.61	5.32	4.53	1.57
	Conical 1/12.	4.37	18.70	4.78	18.31	5.14	17.13	5.28	15.55	5.28	13.00
	Conical 1/6.	4.33	23.43	4.77	23.04	5.15	21.85	5.32	20.67	5.37	19.29
14.76	Cylindrical.	3.94	15.98	4.28	15.78	4.57	13.00	4.65	12.21	4.67	10.04
	Conical 1/12.	4.13	21.85	4.49	21.55	4.94	20.57	5.11	20.08	5.12	17.92
	Conical 1/6.	4.12	26.97	4.53	26.38	4.92	25.79	5.10	25.00	5.14	23.43
15.75	Cylindrical.	3.74	18.70	4.06	18.70	4.37	17.13	4.51	16.34	4.45	12.40
	Conical 1/12.	3.78	25.00	4.13	25.00	4.55	24.21	4.74	19.49	4.74	21.06
	Conical 1/6.	3.78	30.51	4.15	30.51	4.57	29.75	4.74	25.94	4.80	26.58

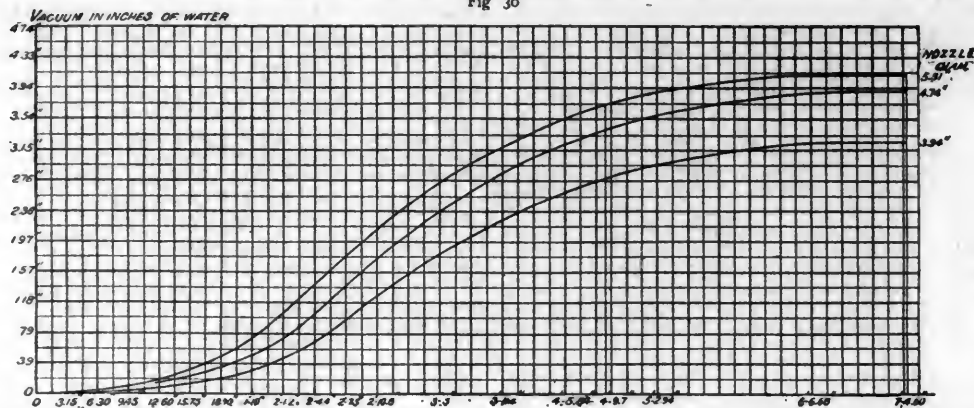
1. The vacuums given are the maxima produced with a steam pressure of 160 mm. (6.14 in.) of mercury. 2. The corresponding nozzle locations here indicate the distances from the top of the nozzle to the bottom of the stack, at which the highest vacuum was obtained. 3. In order to get the distance from the nozzle to the narrowest portion (the waist) of the stack we must add 17.12 in. to the amount given in the table.



(b) Stacks Shortened 11.81 Inches (300 mm.).

Exhaust Nozzle Diameters.												The stack of 13.78 in. diameter was not shortened.
Stacks.		3.94 in.		4.33 in.		4.74 in.		5.12 in.		5.51 in.		
Diam.	Shape.	Vacuum.	Nozzle Location.	Vacuum.	Nozzle Location.	Vacuum.	Nozzle Location.	Vacuum.	Nozzle Location.	Vacuum.	Nozzle Location.	
Inches.	Inches.	Inches.	Inches.	Inches.	Inches.	Inches.	Inches.	Inches.	Inches.	Inches.	Inches.	
14.76	Cylindrical.	3.74	19.10	4.02	18.70	4.33	17.72	4.34	15.55	4.29	13.98	
	Conical 1/12.	3.88	24.02	4.22	23.62	4.59	22.64	4.75	21.26	4.78	20.20	
	Conical 1/8.	3.88	28.35	4.27	28.35	4.61	27.36	4.78	26.88	4.79	25.48	
15.75	Cylindrical.	3.68	23.43	3.89	21.85	4.18	21.26	4.27	19.26	4.21	16.54	
	Conical 1/12.	3.62	29.73	3.96	28.15	4.35	27.56	4.49	26.58	4.51	24.41	
	Conical 1/8.	3.58	31.30	3.96	31.30	4.35	30.71	4.49	30.32	4.57	28.15	

Fig 36



From this diagram we see that the highest vacuum was obtained with a stack length of 6 feet 7.53 inches, which is about 4.7 times the diameter, that it falls rapidly with the decreasing length until at 2 feet 7.5 inches it begins to drop more slowly, and gradually dies away at the zero point.

We see, therefore, that with stacks having a length of from 2 feet 6 inches to 2 feet 11 inches, measured from the nozzle opening, or a length equal to about twice the diameter, air comes in from above and that this influx increases as the length decreases. The current of steam with its surrounding mantle of air no longer fills the whole sectional area of the stack, and consequently the external air can be drawn into the apparatus. The same phenomenon was also observed by Zenner and Priemano.

From tables X. and XI. it also follows that the same vacuum can be obtained with different lengths of stacks having the same diameters if the position of the nozzle is properly adjusted.

The shorter the actual stack, by just so much must the position of the nozzle be lowered if the vacuum is to remain the same, and the longer the stack, the higher must the nozzle be placed.

The great influence that a lowering of the nozzle has upon the vacuum, especially when the stack has been shortened, is clearly shown in Table XII.

TABLE XII.

Diameter of nozzle, inches.	Increase of the vacuum for a stack 15.75 inches in diameter, that had been shortened 19.68 inches as above, when the position of the exhaust nozzle is dropped from 19.68 inches to 39.37 inches below the bottom, the total height thus remaining unchanged.		
	Cylindrical.	Conical, $\frac{1}{2}$ inclination.	Conical, $\frac{1}{4}$ inclination.
3.91	From 2.28 to 3.37 in. = 47.4 per cent.	From 1.89 to 2.95 in. = 75.0 per cent.	From 1.48 to 3.15 in. = 116 per cent.
4.33	From 2.56 to 3.7 in. = 44.6 per cent.	From 2.19 to 3.62 in. = 65.7 per cent.	From 1.77 to 3.50 in. = 97.7 per cent.
4.74	From 2.83 to 4 in. = 41.0 per cent.	From 2.48 to 4.03 in. = 62.3 per cent.	From 2.05 to 3.88 in. = 88.4 per cent.
5.12	From 3.08 to 4.13 in. = 34.6 per cent.	From 2.73 to 4.17 in. = 33.6 per cent.	From 2.30 to 4.07 in. = 76.9 per cent.
5.51	From 3.25 to 4.03 in. = 23.6 per cent.	From 2.93 to 4.25 in. = 45.0 per cent.	From 2.52 to 4.21 in. = 67.1 per cent.

It is worthy of noting just here that where the foregoing position of the exhaust nozzle was 19.68 inches (500 millimeters) from the bottom of the stack, the vacuum belonging to the cylindrical stacks was almost exactly .8 inch higher for each of the five diameters of nozzles than that belonging to the conical stacks, with an inclination of $\frac{1}{2}$, and about .35 in. greater than those with an inclination of $\frac{1}{4}$; while when the nozzle was dropped to 39.37 inches the vacuums were practically the same. The same difference of from .35 inch to .8 in. can also be observed in the diagrams of the curves accompanying the text. It should be thoroughly understood right here that all the text relating to the six plates, inclusive of the technical portions, was first compiled after the latter had been entirely completed.

The correspondence of the vacuum with the nozzle at a distance of 39.37 inches which has been mentioned, is probably due to the fact that the stack will be filled with the current of steam in its smallest cross-section when the nozzle stands at 27.5 inches so that at 39.37 inches it (1,000 mm.), taking the loss of velocity into consideration, the vacuums will be the same for all three forms.

The question as to how much the nozzle distance must be increased for a given shortening of the stack, if the same vacuum is to be maintained as belonging to the unshortened stack is answered in Table XIII.

TABLE XIII.

Shape of Stack.	The increase in the nozzle distance required for maintaining a constant vacuum, when the stack is shortened by		
	11.81 in.	19.68 in.	27.56 in.
Cylindrical	12.80 in.	18.90 in. to 20 in.	27.5 to 28 in. (with diameters of 17.75 in. only or more.)
Conical $\frac{1}{2}$ incl.	7.87 in.	13.00 in.	18.9 in.
Conical $\frac{1}{4}$ incl.	3.25 to 4.74 in.	7.87 in.	12.6 in.

From this it will be seen that the increase of distance is less than the amount of the shortening with the conical stacks, while with the cylindrical stacks it remains about the same. It appears, too, that the total working height of the former from the nozzle to the top of the stack is not the same, but decreases as the stack is shortened by the corresponding failure of the nozzle distance to keep pace with the same, and this also holds true the wider the opening at the

top. For example, suppose a conical stack with an inclination of $\frac{1}{2}$ to be shortened at the top 3.94 inches (100 mm.), the corresponding increase of nozzle distance would be about 1.6 inches, while for a stack having an inclination of $\frac{1}{4}$ it would be about 2.8 inches.

It is an interesting conclusion to be drawn from tables X. and XI. that, as shown by table XIV. which follows, it is possible to maintain the same maximum vacuum with different shapes and lengths of stacks by merely changing the position of the exhaust nozzle.

(To be Continued.)

Trade Catalogues.

[In 1891 the Master Car-Builders' Association, for convenience in the filing and preservation of pamphlets, catalogues, specifications, etc., adopted a number of standard sizes. These are given here in order that the size of the publications of this kind, which are noticed under this head, may be compared with the standards, and it may be known whether they conform thereto.]

It seems very desirable that all trade catalogues published should conform to the standard sizes adopted by the Master Car Builders' Association, and therefore in noticing catalogues hereafter it will be stated in brackets whether they are or are not of one of the standard sizes.]

For postal-card circulars..... 3 3/4 inches by 6 1/4 inches.
Pamphlets and trade catalogues..... 3 3/4 inches by 6 inches.
Specifications and letter-paper..... 5 inches by 12 inches.
The "CLEVAUC" STEAM SPECIALTIES. The Clarence E. Van Auken Co., 166-174 South Clinton street, Chicago, Ill. 40 pages, 6 inches by 9 inches.

The specialties illustrated in this catalogue bear the stamp of originality combined with neatness and simplicity of design. The company say their line of steam specialties is larger and more complete than that of any other concern, and the catalogue certainly shows an extensive line of these goods. The first illustration is of a safety water column, the alarm valve of which is worked by buckets instead of floats. These are always full of water and are in no danger of collapse. Then follow regulators for high and low pressures, noiseless back-pressure valves for either horizontal or vertical pipes, pump governors for elevator and water works pumps, house pump governors, air compressor governors, syphon automatic air valves, high and low pressure steam traps and other devices. The most approved methods of applying some of these mechanisms are illustrated by diagrams. The steam traps mentioned are constructed on a new principle, giving continuous discharge, and operating without pressure in the trap. The cover can be removed while it is in operation without shutting off the pressure. Some of these traps are operating in plants carrying 225 pounds pressure.

The catalogue is embellished by numerous full-page illustrations of notable buildings in which the Clevauc specialties are in use.

ILLUSTRATIONS OF THE SPECIAL LINE OF MACHINE TOOLS. For Working Iron and Steel Plates, Bars and Structural Shapes. Built by Hilles & Jones Company, Wilmington, Del., 32 pages, 8 1/2 by 12 inches.

This publication was evidently intended to be of the standard size of 9 by 12, but the binder has trimmed it a quarter of an inch too small in one direction. It consists as its title implies of illustrations only, without any descriptive matter relating to the machines represented. The engravings are mostly of the half tone variety. These represent a number of heavy shearing and punching machines, plate planers, beam coping and straightening machines, bending rolls and a milling machine. The illustrations in the latter part are very good wood engravings, and are generally very fair, but some of them would have been improved if the machines had been a little more carefully painted before they were photographed.

The illustration on page 10 is an example, some of the cast iron of which looks as though it was suffering from a cutaneous eruption. In view of the importance of photography to the mercantile department of mechanical engineering, it may be expected that in the near future, a photographing room, provided with the best light and other accessories for producing good pictures will be required in every first class establishment.

THE STANDARD WATER TUBE SAFETY BOILER. The Standard Boiler Company, Marquette Building, Chicago, Ill. 16 pages, 6 1/2 by 9 1/2 inches. (Not standard size.)

This pamphlet gives first an isometrical view of one of their boilers, with part of the brick work removed, and then a longitudinal section in outline. After this what is called a "description" of the boiler is given, but which is

in reality only assertions of its advantages. The criticism which should be made here is that if the publishers had given a fuller and clearer description of their boiler, so that the reader could get a clear idea of its construction that then the vaunting of its merits, would produce a much greater impression than it now does. It should be remembered in writing such literature, that nine readers out of ten, are absolutely ignorant of the construction of the objects described. The first thing to do then—and generally the first thing the reader wants to know—is how is it made? and how does it work? After he understands this, then it is in order to boast of its merits. To illustrate what we mean—something is said about the tubes of the boiler being expanded in the wrought steel headers, but there is no description of these "headers," although they may, and probably do, have all the merits claimed for them, yet a person about to buy a boiler before doing so would certainly want to know more about them than the makers have told us in the publication which is here reviewed. The rule to be observed is to describe first as fully and as clearly as possible, and then boast, brag and hustle afterwards.

Perspective views of a 4,000 horse-power installment of these boilers, for the North Chicago Railway; two others, showing "headers" and drums, ready for shipment; an outside view of a power station; other engravings, showing a boiler front, the inside of the works and a sectional view of the building of the Second Avenue Traction Company of Pittsburgh, Pa., are given. Lists of users of these boilers, and testimonials of their merits are also added.

"THE NORWALK" AIR AND GAS COMPRESSOR. Manufactured by the Norwalk Iron Works Company, South Norwalk, Conn., 106 pages, 7 by 9 1/2 inches. (Not standard size.)

The extended use of compressed air for so many purposes gives especial interest at the present time to a catalogue devoted to machinery of this class. Interest, too, is greatly increased when the subject is treated as well as it is in the publication before us, and which is evidence of the fact to which we have often called attention, that the best literature relating to many subjects is now found in catalogues of this kind.

The extent and the variety of uses to which compressed air is now used is indicated by the following observations in the introduction to this book. It is there said: "Old uses (of compressed air) have been extended; abandoned plans have been revived and economically carried out; many new processes, using compressors, have been developed, and experimenters are still busily engaged in further extending the uses of compressed air. We have been called upon to build machines to develop heat, and to produce cold; to move air with a force hardly greater than the breath of a child, and to blow a shot from a cannon; to lift tons of iron, and to clean a watch; to steer a vessel and to launch the torpedo to destroy her."

The book begins with a general introduction of the subject, which is followed by illustrations of eight different patterns of compressors, which have been successively developed. A brief description of their points of difference is given, but would have been more satisfactory if it had been made fuller and had been illustrated with sectional views. Twelve pages are then devoted to a description of the principles and the construction of the "Norwalk Compressors," which is illustrated by another drawing of one of them with some of the internal parts represented by dotted lines. A chapter on the capacity of these machines is followed by very good engravings and descriptions of the different patterns and types which are made. There are in all 26 different air compressors and six gas compressors illustrated. Besides these there are three special compressors shown which are intended for charging pneumatic locomotives, several forms of the latter being also shown.

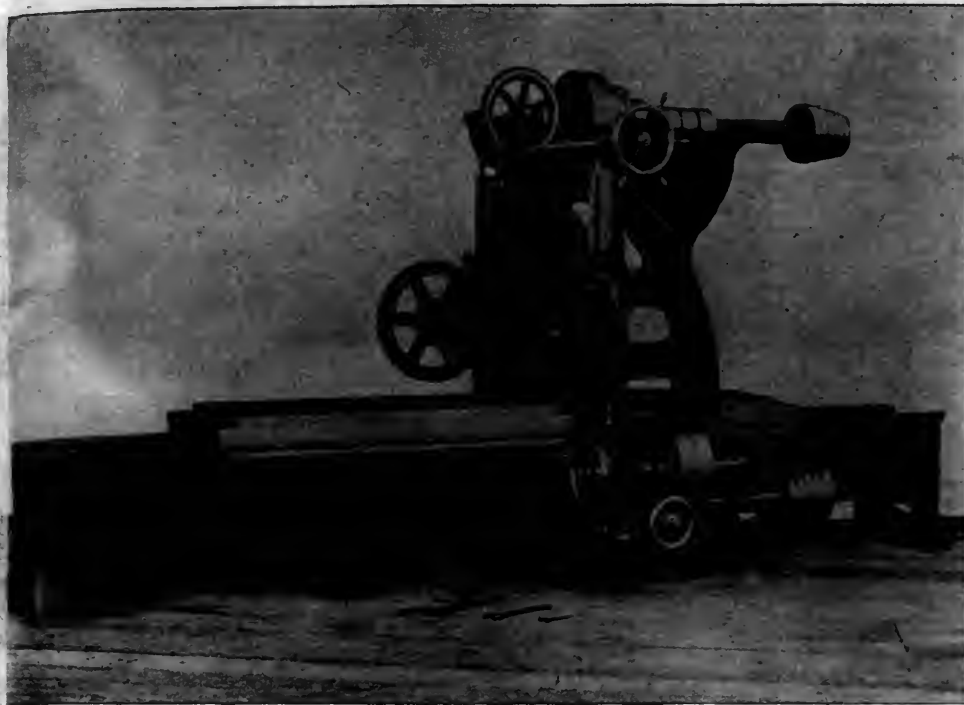
A view of Captain Glassford's army balloon, which was inflated with hydrogen gas that was compressed in steel tanks by one of these machines, is given, and also one of the dynamite cruiser *Vesuvius* whose guns are operated by air compressed by a Norwalk machine to a pressure of 5,000 pounds per square inch. There is also an engraving of a compressor for the monitor *Terror*, on which compressed air is used for many purposes as a substitute for steam in places remote from the boilers, or when exhaust steam would be a menace to health and safety.

A disappearing gun and carriage erected at the entrance of New York harbor is also shown, which is loaded, moved into position and aimed by compressed air. At the end of the book a number of special forms of compressors—some with oscillating cylinders and others placed vertically—are shown. The catalogue ends with an essay on the efficiency of compressed air engines, another on the requirements of rock drills and a very good index.

The book is well printed on good paper and the engravings are excellent. The only criticism for which there seems to be any ground is that it is not a standard size and the cover has a sort of gay and frisky style hardly consistent with the sober character of the subject and the contents of the book.

RULES. Darling, Brown & Sharp, Providence, R. I. 12 pages. 3 by 5 1/2 inches. (Not standard size.)

The purpose of this little catalogue is to describe the well-known steel rules made by this company. It is also announced that they now make "tempered rules" as accurately graduated as the Standard, or soft, rules are. The catalogue contains engravings and tables of sizes, etc., of this company's products.



Milling Machine for Horizontal and Vertical Milling.

Milling Machine for Horizontal and Vertical Milling.

Most of the milling operations in which our readers are interested are heavy enough to require a machine of more than ordinary strength, and it may be truly said that if milling tools are to supplant the planer to any great extent they must be of a very substantial character. The machine we illustrate has been designed by the firm of Bement, Miles & Company, Philadelphia, Pa., with a full knowledge of this fact, and is capable of doing the heaviest class of milling. It has a substantial bed and housings. The spindle has large bearings, adjustable for wear, and is geared eighteen times from a 24-inch cone driven by a 6-inch belt. The table is from 20 inches to 28 inches wide on the clamping surface, and is gibbed down to the bed. It traverses by hand or power, by means of a spiral pinion, which gives a perfectly smooth motion. It is also provided with a quick movement in either direction by friction pulleys. Surrounding the table is a tray which leads the lubricating fluid into a tank behind the machine. The distance between uprights is from 26 inches to 36 inches. The machine can be built so that the cross slide, which is counterweighted, will raise to any desired height above the table. There is an adjustable support for the outer end of the cutter bar, and the spindle has horizontal adjustment to suit various lengths of cutters up to the full width of the table.

The feed can be varied from one to nine inches per minute and is provided with an automatic stop motion for throwing out at any desired point. All the gearing is cut from the solid, all shafts are steel running in bronze bushings, and the workmanship on the machine is thoroughly first-class. All parts are made strong, heavy and of the best

The Hunt Coupling for Transmission Rope.

The rapid increase in the transmission of power by rope has made prominent one of the minor difficulties attending its use. This is the gradual lengthening of the rope which increases the sag until it becomes necessary either to resplice the rope or to use a take-up sheave with a very long range of motion. Rapid wear of the rope from slipping on the pulleys is frequently caused by lack of sufficient tension.

The Hunt rope coupling, which we illustrate, is designed to do away with all necessity for resplicing, etc., as it will keep a rope at exactly the right tension for the most effective service and long life, and do this with little or no extra time or attention being given the matter and with no expense other than the first cost of the coupling. The device is made wholly of aluminum bronze and has a tensile breaking strength of 60,000 pounds to the square inch, and an elongation of 20 per cent. in eight inches, which is equal to the strength and toughness of mild steel. It is very simple in its construction, there being but two parts, consisting of a screw and socket. These screw together when the rope is first put on the pulleys and lock securely, so that the coupling can be separated only by using a wrench of special design.

A very important and interesting feature of the coupling when screwed together is an internal swivel and ratchet, which we show in Fig. 3. The swivel permits the joint to yield to the curvature of the pulleys while the ratchet holds the parts from revolving on each other and untwisting the rope.

The Hunt coupling is made smaller in diameter than the rope with which it is to be used, in order that it may not

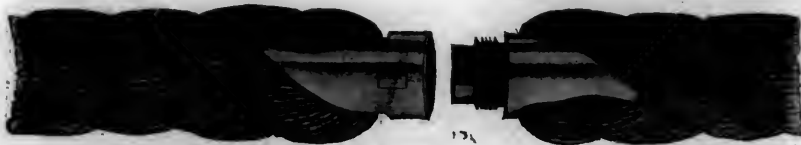


Fig. 1.

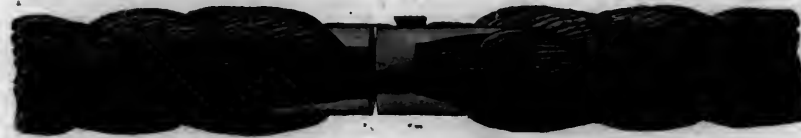


Fig. 2.

The Hunt Coupling for Transmission Rope.



Fig. 3.

material. The various handles controlling the actions of the machine are so located that they can all be operated from the most convenient position for the operator. Two counter-shafts, all necessary wrenches, a pump and two tanks for circulating lubricant to the cutters, are provided with the machine.

The machine can be built of any required length. Also an additional head for vertical milling cutters can be applied to the cross-slide without destroying the arrangement of the heads for horizontal milling. The vertical head is driven from the same gearing and the application is very simple. This tool is designated by the manufacturers as their No. 6 milling machine.

Mr. Hiram S. Maxim has consented to write a series of important illustrated articles on the evolution and manufacture of automatic firing guns, the first of which appears in the current issue of *Industries and Iron*.

In the ordinary manner, and it is also less than a rope drive with a tension pulley, which, in addition to its cost, frequently requires space that is useful for other purposes. When we consider that a rope requires to be spliced two or three times during its life, while the couplings having no wear are permanent, with no further expense after once installed, it will be seen that this method is much the cheaper as well as the better one.

The advantage, both in the convenience of installation, the facility of adjustment of tension, the perfect control of the sag, and the increased life of the rope from a more equal tension, are sufficient to justify an expenditure of many times their cost.

The C. W. Hunt Company, 45 Broadway, New York City, are the exclusive licensees in the United States for the patent on this coupling, and are prepared to furnish transmission rope of the well-known "Stevodore" brand and of the usual sizes with the couplings spliced in position.

An Invitation to Strike.

Some workmen who are careless make a practice of striking the vise of a shaper upon the ends to bring it up square, using a hammer or anything else that happens to be handy, thus bruising the sliding surfaces and in a short time practically ruining the vise for efficient work. The evil effects thus produced are very plainly shown on the engraving of an old vise subjected to just such usage, which can be seen in the vise marked "Without." To prevent this, Gould & Eberhardt, the prominent machine tool builders of Newark, N. J., have been making the new and original style of vise shown above the old vise, which is furnished with all their shapers of latest design, and which does not lessen their usefulness nor reduce their capacity.

In this vise, provision is made whereby it may be tapped on the end for such fine adjustment as may be required



without in the least injuring the vise in any way. To keep the matter continually before the workman, the makers have cast the word "Strike" on the vise, also arrow-points showing where to strike. It has often been asked by mechanics why the word "Strike" is cast on this vise. The reason is as explained above.

This is a machine-shop kink of much practical value and is original with Gould & Eberhardt and to be found only on shaper vises of their manufacture.

The Fox Pressed Steel Company.

For several months negotiations have been under way looking to the formation of a large concern to engage in the manufacture of Fox pressed steel trucks, as well as other forms of pressed steel which enter into the construction of railroad equipment. These negotiations have been successfully consummated, resulting in the formation of the Fox Pressed Steel Company, composed of New York and Pittsburgh capitalists, whose plant will be located in Pittsburgh. Ample capital has been provided, and the concern have purchased five acres of ground on the line of the Allegheny Valley Railway, near Fifty-second street, and the work of erecting the plant will be commenced at once. The contract for the erection of the buildings and also for the machinery has been let to Mackintosh, Hemphill & Co., of Pittsburgh. This firm will push the work to completion as rapidly as possible, and the new concern expect to be turning out the Fox pressed steel truck about Oct. 1 next.

The plans call for a main building 450 feet long by 112 feet wide. Included in the equipment of this building are 6 power shears, 8 hydraulic presses, 2 bending machines, 11 hydraulic punches, 7 power punches, 24 hydraulic riveting machines, 16 hydraulic cranes, 5 electric cranes, and the necessary straightening tables and other smaller tools. The entire equipment will be of the most modern design. In another building, 350 by 62 feet, will be located the machine shop, blacksmith shop, pump house, boiler house and electric light plant; another and smaller building will contain the gas producers, as it is the intention to use producer gas for fuel.

The location selected for the plant is an admirable one, as the facilities for receiving and shipping material will be all that could be desired. Cars will run right into the building on a private track, and will be loaded and unloaded by overhead electric traveling cranes. The plant will be so constructed that the raw material will be received at one end, put through the various processes of manufacture and loaded on cars at the other end, thus preventing unnecessary and costly rehandling. The entire plant has been carefully designed, and when in full operation is expected to

turn out from 300 to 400 finished trucks per day, and, to give employment to from 1,000 to 1,200 men.

There are now about 60,000 Fox trucks in use and the demand is constantly increasing. The material for the construction of these trucks will be principally supplied by the Carbon Steel Company of Pittsburgh, and will conform in quality with the specifications of that used by the Fox Solid Pressed Steel Company of Joliet, Ill. It is the opinion of many able and experienced railroad men that the Fox pressed steel truck frame will become the standard truck of this country, and there is no question but that where adopted, it will materially reduce the operating expenses of the road by minimizing the wear and tear of both rails and wheel flanges.

As already stated, the Fox Pressed Steel Company will manufacture all forms of pressed steel that enter into the construction of railroad equipment, in addition to the steel truck.

The American Mannesman Tube Company, of Jersey City, N. J., has been incorporated, with \$3,000,000 capital. Buffalo, N. Y., is to be the principal place of business.

The patent litigation between the Consolidated Car Heating Company of Albany, and the Martin Anti-Fire Car Heater Company has been finally adjusted by the purchase of the Martin patents by the Consolidated Company.

Mr. Otto Goetze, who represents in this country the firm of Muller & Mann, manufacturers of rust proof paints and "Mannocitin," a rust preventive for bright parts of machinery, has removed his office to 114 Broad street, New York City.

The Abendroth & Root Manufacturing Company, 28 Cliff street, New York City, have just closed contracts for their Root Improved Water Tube Boiler for the electric light and power plant of the East River Bridge, Munseys new building, and the Electrical Exposition, New York City.

The New York office of the Q & C Company has been removed to Rooms 20, 21 and 22 of the 20th floor of the American Surety Building, 100 Broadway. There is nothing like being away up in the world and those who call at these offices on business or pleasure bent, will have an opportunity to see much of the world and of humanity about him.

Mr. Alex. Backus, President of the Vulcan Iron Works Company, of Toledo, O., has been made President of the Manufacturers' road, a new belt line just completed in Toledo. The first trip over the line was made March 31 and among the first cars handled was one switched to the Vulcan Iron Works to load a monster Vulcan shovel, which, with three others, is destined for the Mesabi Range.

The Schoen Pressed Steel Company, recently organized in Pittsburg with a capital stock of \$1,000,000, have purchased the plant of the Schoen Manufacturing Company, also all of the patents relating to the manufacture of pressed steel specialties owned by the latter concern, including the patents for the manufacture of pressed steel truck frames owned by Charles T. Schoen; this truck frame was illustrated by us last month. The Schoen Pressed Steel Company have bought 5½ acres of land adjoining the present plant of the Schoen Machine Company, in Allegheny. The capacity of the present plant is 125 truck frames per day, but when the additions to equipment and buildings now under way have been completed this will be increased to 300 sets per day. There is also being turned out at present about 75 tons per day of pressed steel car bolsters and other patented specialties. This tonnage will probably be doubled.

The Westinghouse Electric Company has issued a call for a special meeting of its stockholders, to be held on June 4, to vote on a proposition to increase its capital to \$15,000,000. The present authorized capital is \$10,000,000, of which a little more than \$9,300,000 has been issued. The object of the increase is stated to be for the purpose of wiping out existing floating debts and providing additional capital for the increase in business which is expected the coming year, and which will be one of the results of the recent agreement entered into with the General Electric Company. It is said that the increase will be authorized because a number of large stockholders who had been consulted before the call was issued have endorsed the proposition. It is said that \$3,000,000 of the proposed increase has already been disposed of, but the stock will not be issued until formal action is taken at the stockholders' meeting.

The Stilwell-Bierce & Smith-Vaile Company, of Dayton, Ohio, have taken the contract for a complete water power plant to be installed at the Lachine Rapids in the St. Lawrence River. This power is said to be second only to Niagara Falls in importance, and is owned by the Lachine Rapids Hydraulic and Land Company, Limited, of Montreal, Canada. It is located at the famous Lachine Rapids on the St. Lawrence River, about five miles above Montreal. The initial development will amount to 10,000 horse-power. The work of construction has already begun, and the company expect to be prepared to furnish power before the close of this year. They have contracted with the Stilwell-Bierce & Smith-Vaile Company for 66 largest size Victor turbines of the latest pattern, and all machinery needed for transmitting the power of these turbines to the electric generators. This is probably the largest order for such equipment ever placed at one time.—*Iron Age*.

The firm of Bruner, Sprague & Company, 1005 Chamber of Commerce Building, Chicago, Ill., are the sole selling agents for the Sall Mountain Asbestos Company. This company has an immense mine of pure short fiber asbestos, located at Sautee, White County, Ga., and is prepared to furnish it at prices so low that it can be used in direct competition with mineral wool and kindred materials; at

the same time it is claimed to be far superior to those materials in quality and durability and goes much farther, pound for pound. It is being used by architects and builders for fireproofing, insulating partitions, and deadening floors; by car builders for insulating refrigerator cars and for deadening material in the floors of coaches and sleeping cars; and by locomotive builders and railroads for lagging locomotives and covering steam pipes and boilers. Among the roads using it for boiler lagging are the Chicago & Northwestern and the Chicago and Eastern Illinois roads.

During the past month we received a copy of a formidable looking injunction, which on closer inspection proved to have come from the American Blower Company, of Detroit, and purported to enjoin competitors from claiming to have the "best blowers," while the American Blower Company's "A B C" hot-blast heater is in the market. Appended is a description of the heater. Ordinarily the steam pipes in the heaters of hot blast apparatus are in the form of an inverted letter U, with the ends connected to a cast-iron base. Each series of pipes is placed within the area enclosed by the next larger one, until all the space is occupied. The outside pipe is thus several times longer than the inner or shortest one, and this difference in length is held to cause marked difference in the circulation of the steam, so that some of the heating surface is inefficient. In the "A B C" heater the inner lines of pipe are given convolutions so as to make all pipes of practically the same length, and thus avoid "short circuiting" of the steam. Furthermore, the base is made in two sections, and so designed as to prevent air pockets. The valves and fittings are all at one side of the base for convenience in connecting to them. The company will be pleased to furnish additional information to those interested.

At Rice's Point, opposite the entrance of the harbor at Duluth, Minn., is a coal dock of great size owned by the Ohio Coal Company, which has recently been newly equipped throughout with the most improved appliances for handling coal. The dock is 1,500 feet long and 300 feet wide, a double railway track extending through its center. It has a shed 950 by 150 feet, with watertight roof, for housing all the anthracite coal received, and the daily unloading capacity is 4,000 tons, the coal being handled by the Newell & Ladd self-filling or clam-shell buckets, made specially heavy for digging soft lump coal, while the carriages by which the loaded buckets are conveyed from the dock front to the pockets in the center—150 feet—or dumped at any intermediate point, were made by W. S. Boyle & Company, of Chicago. There are ten 60-horse-power Mundy engines and five 100-horse-power boilers, anthracite dust being used as fuel and steam being furnished to the movable towers along each side of the dock by an 8-inch pipe, 3,500 feet long, provided with 125 openings, permitting the making of connection with the main pipe at almost any point where it is necessary to place the hoisting rig. The whole equipment is deemed especially advantageous for the handling of big lump coal, which has heretofore been done by hand labor only.—*Scientific American*.

At the shops of Beaman & Smith, Providence, R. I., a large horizontal boring mill has just been completed for an electrical concern, and is to be used principally in boring out the fields of dynamos. It has an 8-inch spindle and will bore a hole 5 feet in diameter. The spindle can be adjusted to any required height, up to 6 feet from its center to the plates. The maximum distance between housings is 14 feet, and the platen is 8 feet by 19 feet. The gearing, and for that matter all the other parts, are of the best. The spindle passes through bearings that are lined with a thin conical sleeve or bushing of brass or bronze, which by adjustment longitudinally is compressed in the direction of its diameter, so as to compensate for wear of the spindle. The bushings are solid, not split. Another interesting special tool under construction at these shops is a machine for making plug cocks for a pipe line concern. It operates at one time on four plugs on one side of the machine and four shells on the other, and has a capacity of about 8,000 per month. One notable feature of the method of finishing the shells is the fact that no reamer is used to finish the tape hole for the plug. It has been demonstrated by the superintendent of the pipe line, that the work can be done more cheaply and with equal accuracy by finishing the hole with ordinary boring tools.

On the evening of April 16, a meeting was held at the Manufacturers' Club in Philadelphia, to celebrate an event that was not only a source of pleasure to those present but a genuine gratification to the many friends of Queen & Company of that city. Nearly two years ago that well-known firm assigned to Mr. J. G. Gray, with assets valued at \$400,000 and liabilities aggregating about \$184,000. The confidence of the creditors was such that the business was continued without interruption. Now the creditors have been paid in full, the receivership at an end, and the business placed in the company's hands with no liabilities and assets of more than \$200,000. The gathering at the Manufacturers' Club was to celebrate this event. Mr. Gray was presented by the creditors with a magnificent set of the Encyclopedia Britannica, for his skillful management of the business, the several addresses contained much praise for both Mr. Gray and Queen & Company. The house of Queen & Company was established in 1853 by James W. Queen, who had previously been a member of the firm of McAllister & Company. He had made the original firm a scientific center, and on establishing the new house he naturally carried with him the scientific connections which he had formed. He was known to all the scientific men of his day, and they delighted to visit his establishment. Mr. Queen instituted the greatly reduced weight in spectacles, as they are now made. He imported the first forms for grinding spectacle glasses that were used in the United States. He made the first kaleidoscope, the first magic lantern, stereopticon, stereoscope, microscope and platina points for lightning rods. In 1853, failing health lead him to seek a partner in the business and he invited Mr. Samuel L. Fox, who had been a lad

under him at the old establishment, and was then 24 years of age, to join him as an equal partner. The firm's name then became James W. Queen & Company. In 1870 Mr. Queen retired from business, selling his interest to Mr. Fox, who continued the firm name of James W. Queen & Company, until the year 1893, when the stock corporation of Queen & Company was formed. The assignment which the company was obliged to make in 1894 was due to the expansions, made in good judgment by it, in the manufacturing and store plants in 1892, to meet the increasing demand for scientific instruments and to the business depression which took place in 1893 over the whole world.

John C. Gray, the assignee of the company, has been connected with James W. Queen & Company and Queen & Company since 1882. In the reorganization of the company Mr. Gray assumes the Presidency. Mr. S. L. Fox is Vice-President, and Mr. J. M. Hazel, Secretary and Treasurer.

Our Directory

OF OFFICIAL CHANGES IN APRIL.

We note the following changes of officers since our last issue. Information relative to such changes is solicited.

Adirondack & St. Lawrence.—Charles H. Burnett has been appointed Purchasing Agent with office at 51 East 44th Street, New York City.

Altoona & Philadelphia Connecting.—Mr. Henry Levi has been elected President to succeed S. P. Langdon.

Atlantic and Pacific.—C. W. Smith is Receiver and General Manager, with office at Albuquerque, N. M.

Boston & Albany.—Mr. Thomas B. Purves, Jr., has been appointed Superintendent of Rolling Stock, and will have charge of both the locomotive and car departments, with office at Springfield, Mass.

Mr. William H. Taft, now Acting Superintendent of Motive Power, has been appointed Superintendent of Motive Power, with office in Boston.

Mr. C. H. Barnes has been appointed Division Master Mechanic at West Springfield, Mass.

Central Vermont.—Messrs. Charles M. Hays, General Manager of the Grand Trunk, and Edward C. Smith, President of the Central Vermont, were on March 20 appointed Receivers.

Cleveland, Akron & Columbus.—Mr. B. F. Marshall has been appointed Master Mechanic, with headquarters at Mount Vernon, O., to succeed Mr. W. J. Vance, resigned.

Drummond County.—Mr. C. Church has resigned as president.

Eastern Railway of Minnesota.—Mr. Howard James has been appointed Purchasing Agent, with headquarters at Duluth, Minn.

Grand Trunk.—Mr. Hebert Wallis has resigned the position of Mechanical Superintendent, and Mr. F. W. Morse has been appointed his successor.

Gulf & Interstate.—Mr. W. A. Meagher has been appointed Master Mechanic, with headquarters at Galveston, Tex.

Interoceanic of Mexico.—Mr. G. M. Stewart has been appointed General Manager, with headquarters at the City of Mexico.

Los Angeles Terminal Railway.—Mr. T. E. Gibbon has been appointed Vice-President, and Mr. Wm. Wincup Acting General Manager in charge of traffic and operation, vice T. B. Burnett.

Louisville, Evansville & St. Louis.—Mr. G. F. Jarvis' appointment as the sole receiver of the Louisville, Evansville & St. Louis road, to succeed Receivers Hopkins and Wilson, takes effect May 1.

Macon & Birmingham.—Mr. Julian R. Lane has been appointed General Manager.

Macon & Northern.—Mr. Edgar A. Ross has been appointed Receiver in place of Mr. William H. Ross.

Mexican Railway.—Mr. E. G. Evans has resigned as Locomotive Superintendent and Mr. Alfred Atwood has been appointed to succeed him with headquarters at Apizaco, Mexico.

Michigan Central.—On the decease of Mr. C. E. Smart the office of General Master Mechanic was abolished and the office of Superintendent of Motive Power and Equipment created. Mr. Robert Miller is appointed to the position, and Mr. R. H. L'Hommedieu becomes General Superintendent.

Middle & East Tennessee Central.—Mr. W. W. Fidler has been appointed General Manager, with office at Hartsville, Tenn.

Norfolk & Ocean View.—The office of General Manager has been abolished and that of Superintendent created. Mr. W. A. Barritt, late General Manager, retires, and Mr. Lee D. Matheis is appointed Superintendent.

Northern Ohio.—Mr. John T. Clark has been appointed Master Mechanic with headquarters at Delphos, Ohio.

Ohio Southern.—N. E. Matheis has been appointed Purchasing Agent, with office at Springfield, O., vice C. H. Rozer.

Oregon Central & Eastern.—Offices of Master Mechanic and Master Car Builder have been abolished.

Pittsburgh, Lisbon & Western.—C. H. Smith will be General Manager of this road, which is the reorganized Pittsburgh, Marion & Chicago.

Southern.—Third Vice-President W. W. Finley has resigned.

St. Louis, Chicago & St. Paul.—Mr. Henry W. Gays has been made General Manager. General Superintendent I. W. Fowler has resigned and the office has been abolished.

Wabash.—Mr. F. W. Morse has resigned the position of Division Master Mechanic at Fort Wayne.

Employment.

WANTED.—A Superintendent for a small car works Active, practical and thoroughly up in car building. Address, with references, THE RATHBURN COMPANY, Deseronto, Ont., Canada.

A GRADUATE ENGINEER, of eight years' experience in a special line of railroad supplies, having a large acquaintance among railroad men, and car builders, desires a position where such knowledge and experience will be of value. Address, W. C. S., Room 36, No. 2 Exchange Court, N. Y. CITY.

then 24
partner,
company,
s inter-
mes W.
rock cor-
ignment
is due to
he man-
creasing
ness de-
rid.
een con-
neen &
company
is Vice-
urer.

our last
ited.

as been
ast 44th

y Levin
General

as been
ill have
s, with

Motive
Power,
ster Me-

General
s, Presi-
pointed

hall has
rters at
ned.

as presi-

nes has
rters at

he post-
r. Morse

een ap-
veston,

een ap-
City of

pon has
up Act-
on, vice

Jarvis'
Evans-
na and

een ap-

een ap-

s Loco-
as been
pizaco,

Smart
ed and
pment
on, and
dent.

er has
taville,

anager
reated.
ed Mr.

ointed

ed Pur-
C. H.

olic and

will be
anized

has re-

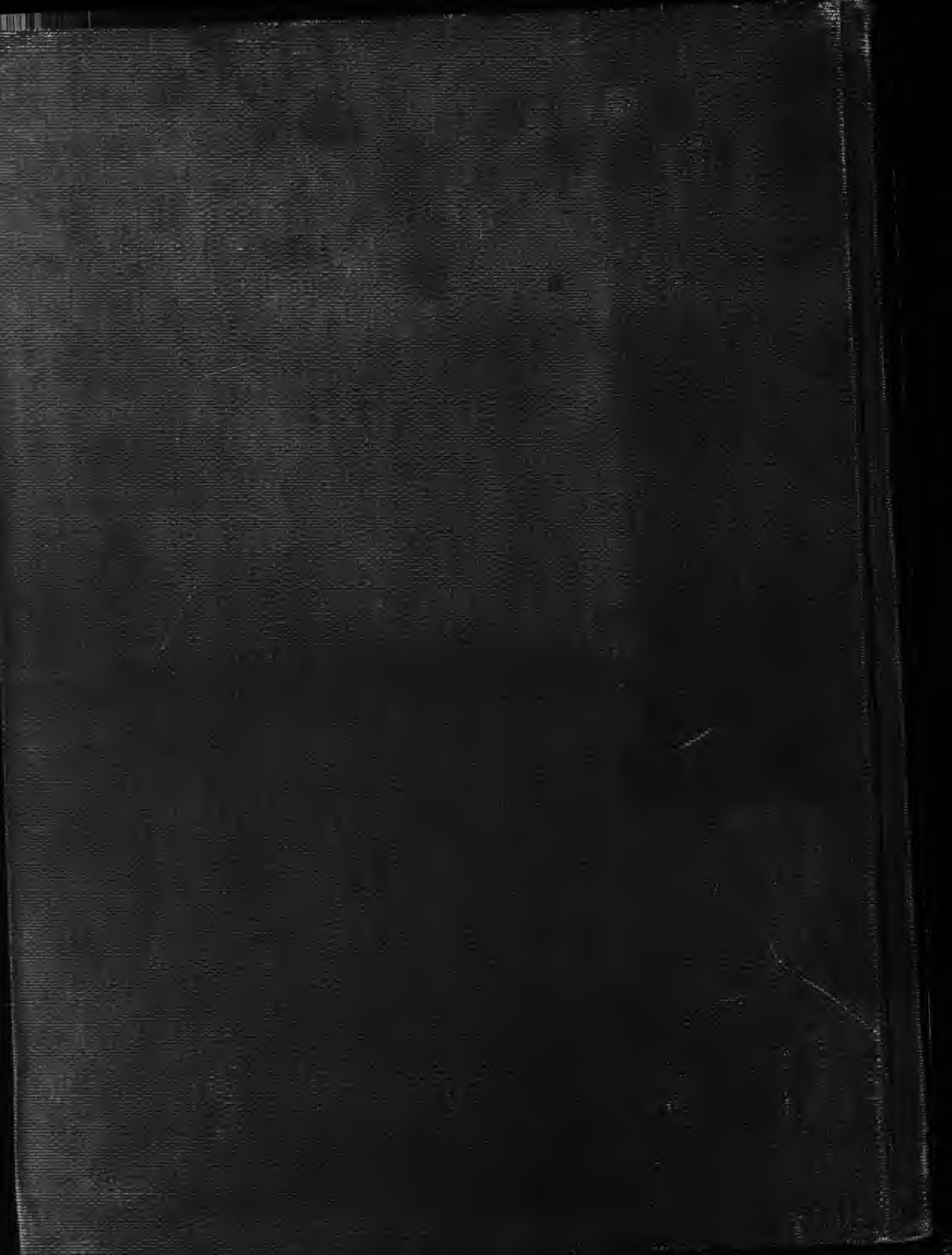
ya has
ent I.
hed.

tion of

works
R. Ad-
eronto,

ce in a
ntance
osition
e. Ad-
City.

From p. 89 in smaller form
and bound in a separate
volume.



**AMERICAN
ENGINEER AND
RAILROAD JOURNAL**

NEW YORK [ETC.]

V. 70, June-Dec., 1896

IRREGULARITIES

TITLE: American engineer and railroad journal

FILM NO.:

VOLUME/PART/DATE: v. 70, part 2, June-Dec., 1896

ITEM NO.:

ILLEGIBLE/DAMAGED TEXT:

VOLUMES/PARTS/ISSUES MISSING:

PAGES MISSING:

IRREGULAR VOLUME/PART/ISSUE NUMBERING, TEXT COMPLETE:

IRREGULAR PAGINATION, TEXT COMPLETE:

VOLUMES/PART/ISSUES MISNUMBERED:

PAGES MISNUMBERED:

OTHER: V. 70-72, 1896-1898, have title *American Engineer, Car Builder, and Railroad Journal*.

The person charging this material is responsible for its return to the library from which it was withdrawn on or before the **Latest Date** stamped below.

Theft, mutilation, and underlining of books are reasons for disciplinary action and may result in dismissal from the University.

UNIVERSITY OF ILLINOIS LIBRARY AT URBANA-CHAMPAIGN

BUILDING USE ONLY
JUL 27 1974

AMERICAN ENGINEER CAR BUILDER AND RAILROAD JOURNAL

JUNE, 1896.

THE ALTOONA SHOPS OF THE PENNSYLVANIA RAILROAD. REMOTE STORAGE I.

The principal shops of the Pennsylvania Railroad for the repair and construction of cars and locomotives, as most of our readers know, are located at Altoona, and, as many of them are also aware, this place is a sort of mechanical Mecca to which many pilgrimages are made, by those who are in pursuit of information or enlightenment on the many abstruse problems relating to the mechanical engineering of railroads. A visit to this place is therefore always interesting, and it is hoped that some notes and observations of a recent ramble, through the great works which are established there will be interesting and may be profitable to our readers.

For the following facts regarding the location of Altoona and its surroundings, we are indebted to an illustrated "historical descriptive and statistical" volume published by its Beard of Trade.

"The city of Altoona was laid out in 1849 and the Pennsylvania Railroad commenced the construction of its shops in 1850. It is situated about thirty miles southwest of the geographical center of the great State of Pennsylvania, just at the eastern base of the Allegheny Mountains, near the headwaters of the Juniata River—the 'Blue Juniata' of Indian legend and pale-faced song, and on the line of the Pennsylvania Railroad. It lies in the upper or western end of Logan Valley or 'Tuckahoe,' as the vicinity was called in early days, in the central part of Logan township, in Blair County. By rail it is 117 miles east of Pittsburgh and 235 west of Philadelphia, although an air line would be one-fourth to one-third less. Baltimore and Washington are 150 miles southeast and Buffalo 200 miles directly north, but by rail the distance to these points is nearly twice as great.

"Originally laid out in a narrow valley, it has filled this and climbed the hills on either side and grown in all directions, so that a large part of it is built on hills of moderate elevation. The city lines, as now established, embrace a territory two and one-fourth miles wide, but it is built up as a city a distance of four miles long and two miles wide. Less than 50 years old, it has grown with such surprising rapidity that it now contains a population of over 40,000 and is now the eighth city in the state in population, and second to none in material prosperity.

"The lowest ground in the city is 1,120 feet above the level of the ocean, and the hills rise 100 to 150 feet higher, making the site and surroundings picturesque in the extreme.

"The railroad passes through the heart of the city from northeast to southwest. . . . In the central part of the city, on the lower ground, are located the railroad company's machine and locomotive shops, freight warehouse, passenger station and an immense hotel, around which the business of the city clusters, this being the 'hub'; although the ever-increasing business of the road has necessitated the building of additional shops at two other places in the eastern suburbs."

The "car shops" are located about a half mile east of the locomotive shops and the "Juniata shops," which have been built within a few years for the construction of locomotives, are about a mile east of the car shops.

Elsewhere plans showing the location of each of these three groups of shops are given, and also a view of the yard taken from the west end of it, adjoining the repair shop, and which shows part of one of the engine houses, and of other buildings, and the network of tracks at that point. Another view of the car shops and the grounds adjoining will give an excellent idea of the

appearance of that locality and still another one of the "Juniata shops taken from the north looking southward shows their appearance and that of their environment. The plans represent the shops and grounds, as maps ordinarily do, that is the person looking at them is supposed to be on the south side. As visitors nearly always approach the shops from the north side and as the perspective view of the Juniata shops is taken from the north the plans may at first be a little confusing.

The main or "locomotive shops" as they are called, are the oldest and most extensive and are devoted chiefly to the repair of locomotives, although also some new construction work is done there. The following are the principal buildings and their dimensions:

Middle division round house.....	235 feet diameter
Erecting shop No. 1.....	413 feet by 66 feet
Blacksmith shop (two stories).....	362 " 63 "
Erecting shop No. 2.....	414 " 66 "
Office store room, laboratory and test room (three stories).....	170 " 40 "
Boiler house.....	66 " 43 "
Flue shop.....	125 " 40 "
Boiler and blacksmith shop.....	192 feet diameter
Blacksmith shop.....	249 feet by 56 feet
Wheel shop.....	219 " 66 "
Boiler flange and tank shop.....	124 " 66 "
Wheel annealing pits.....	95 " 58 "
Pittsburg division round house.....	340 feet diameter
Iron foundry.....	245 feet by 96 feet
Wheel foundry.....	137 " 70 "
Core room, pattern shop on second floor.....	80 " 71 "
Brass foundry.....	78 " 55 "
Pattern store room (two stories).....	98 " 48 "
Oil house.....	57 " 47 "
Waxed foundry.....	168 " 65 "
Total floor area.....	367,311 square feet

The car shops, as their name implies, are devoted chiefly to the construction and repair of cars, but a group of small buildings are devoted to work for the maintenance of way. The following are the principal buildings and their dimensions:

Passenger car paint shop.....	42 feet by 132 feet
Electric transfer table and pit.....	397 " 60 "
Group of maintenance of way buildings.....	19,142 square feet
Freight car paint shop.....	392 feet by 108 feet
Freight car truck shop.....	82 " 70 "
Planing mill.....	356 " 74 "
Blacksmith shop.....	357 " 73 "
Machine and cabinet shop.....	363 " 73 "
Upholstering and trimming shop (two stories).....	363 " 73 "
Passenger car erecting shop.....	213 " 133 "
Office and storeroom (two stories).....	79 " 59 "
Freight car shop.....	433 feet diameter
Steam turntable.....	100 " "
Lumber drying kilns.....	3,343 square feet
Fire apparatus.....	53 feet by 33 feet
Total floor area.....	308,680 square feet

The Juniata shops are the newest and were built for the construction of new locomotives. A part of them are now devoted to the repair and construction of frogs and switches and other maintenance of way work. The shops are splendidly equipped with the latest and most approved machinery. The buildings are as follows:

Paint shop.....	146 feet by 67 feet
Electric and hydraulic house.....	60 " 45 "
Boiler shop.....	385 " 80 "
Blacksmith shop.....	306 " 80 "
Boiler house.....	70 " 43 "
Office and storeroom (two stories).....	71 " 51 "
Hydraulic transfer table and pit.....	261 " 60 "
Erecting shop.....	354 " 70 "
Machine shop (two stories).....	258 " 75 "
Total floor area.....	118,966 square feet.

The entire area of the floors of all the shops is 854,980 square feet or 19.7 acres.

It would be very difficult to give a systematic account of all of these shops, and the many interesting processes and appliances which are carried on in them. Only a large book or many chapters would suffice for that purpose. No attempt will therefore be made to arrange our observations in any systematic order, but they will be noted as they were brought to the attention of the writer during a "personally conducted" ramble through these great establishments. Before doing this it will be explained that the engraving of two passenger locomotives on the double page illustration herewith represents the latest type or "Class L" engine built by this company, and also their "Class G" engine, which was built and was the standard type in 1873. The illustration and the following dimensions give a good idea of the increase in size of locomotives within the past twenty-two years.

	Class G.	Class L.
Diameter of driving wheels ..	50 inches	80 inches
Cylinders.....	15 by 22 inches	18½ by 26 inches
Weight.....	65,200 pounds	134,500 pounds
Pressure in boilers.....	125 pounds	185 pounds



JUNIATA SHOPS OF THE PENNSYLVANIA RAILROAD, ALTOONA, PA.



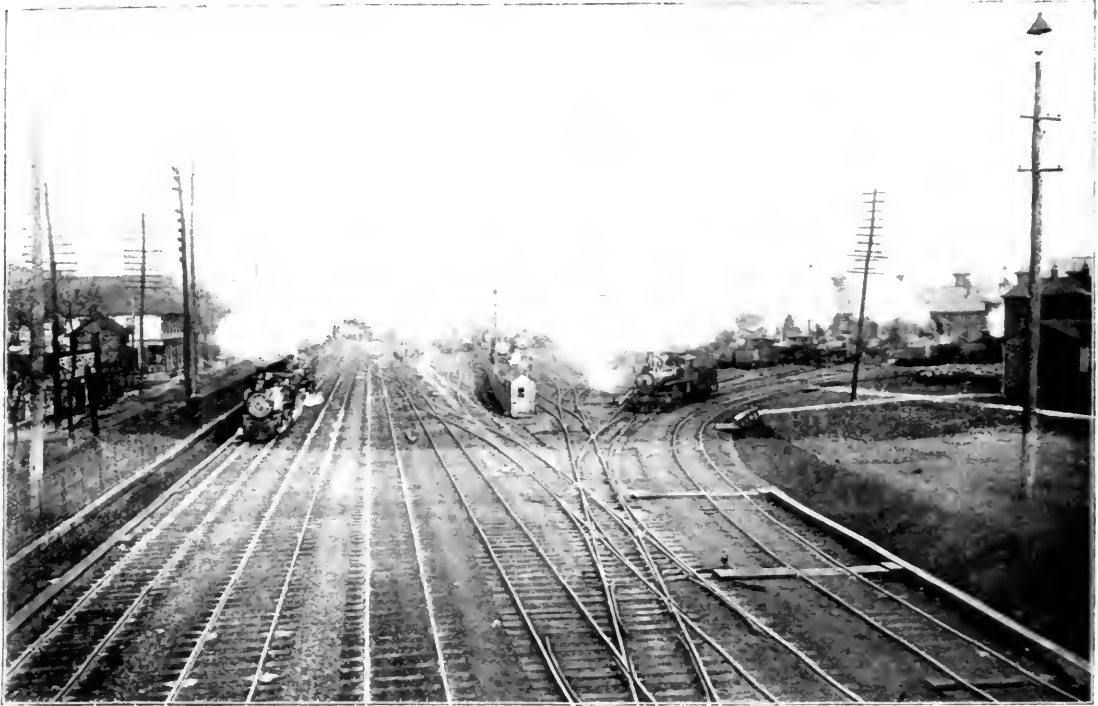
View of West End of Pennsylvania Yard, Altoona, Pa.



Car Shops of the Pennsylvania Railroad Altoona Pa.



JUNIATA SHOPS OF THE PENNSYLVANIA RAILROAD, ALTOONA, PA.



View of West End of Pennsylvania Yard, Altoona, Pa.



Car Shops of the Pennsylvania Railroad Altoona Pa.

We will have more to say about the "Class L" engine in a future article.

The Pennsylvania Railroad Company for many years past has made many of the cast-iron wheels used on its road. In connection with the locomotive shops is a well-equipped wheel foundry where large numbers of wheels are and have been made. Great pains have been taken and much skill exercised to procure the best possible materials for their manufacture, and to produce the strongest, safest and most durable wheels of that kind. Recently an expensive accident occurred on the road while a train was coming down the long and steep grade west of Altoona. The accident was caused by a broken wheel under a foreign car, the failure of which was attributed to the action of the brakeshoes, which were applied in descending the grade, and which heated the wheel, and it was thought thus cracked it. To throw some light on the subject, it was decided to make tests of wheels made by different manufacturers, to determine the effect of heating the tread. To do this the wheels were placed in a sand mould flatwise, with their flanges down and their axes vertical. Around the tread of the wheel a circumferential space was left $1\frac{1}{2}$ inches wide measured radially to the wheel, this space being surrounded with sand, the top of the mould being left open. Into this space molten cast-iron was poured, with the result that in many cases some of the ribs or brackets were cracked in about half a minute after the metal was poured, and the plates in about a minute after the molten metal came in contact with the tread. At the time of the writer's visit to the foundry, which is here reported, three new wheels were prepared for such a test; two of them manufactured by a reputable maker, and one of these two wheels was taken from those supplied by the manufacturer in the regular course of trade, and the other a special wheel furnished for the test, and said by the maker to be the best he could produce. The third was a new wheel made in the Altoona foundry. In one of the tests the molten iron was poured into the space around the tread of the wheel first described, so as to nearly fill it up to the edge of the rim. In forty seconds after the pouring ceased there was a sharp click indicating that one of the brackets was cracked, and in forty-five seconds the upper plate cracked with a report like that of a small pistol. The crack was a radial one through the rim, and it then extended circumferentially just inside the rim about one-sixth of the way around the hub. The second wheel, which was said by the maker to be the best that he could produce, cracked in the same way in the plate in two minutes after the iron was poured, the fractures being of somewhat less extent than the first. The Altoona wheel was then tested, but did not break when the melted iron poured around it had become black by cooling. Other tests have been made of wheels which had been in service with similar results. The Altoona wheels are reported to have stood the test in every case excepting one, while a large proportion of those made by manufacturers who sell wheels were broken. During a considerable part of the time after the iron was poured, when the tests which are described above were made, the wheel was so cool that a person could bear his hand in the inside of the rim, and the plate, excepting the portion near to the rim, was so cool during the whole test that a person's hand could be kept in contact with it without pain. A match moved slowly in contact with the plate from the hub toward the rim immediately after the test was not lighted until it was near the rim.

These tests are certainly very remarkable, important and somewhat alarming. If, as was shown, an ordinary cast-iron wheel is liable to break when its rim is heated to a comparatively low temperature, there is certainly very much more danger attending their use on long grades when the brakes must be applied for considerable periods than is generally supposed, and the responsibility for using cheap and inferior wheels is correspondingly great. The forms of the wheels which were tested were all alike and were of the ordinary double plate pattern, with curved ribs on the back, so that the capacity for withstanding the test in the one case and the failure in the other was probably due to the difference in quality of the material of which they were made. It may be that if the wheels made of inferior material had been of a different form they would not have broken, and this kind of tests supplies

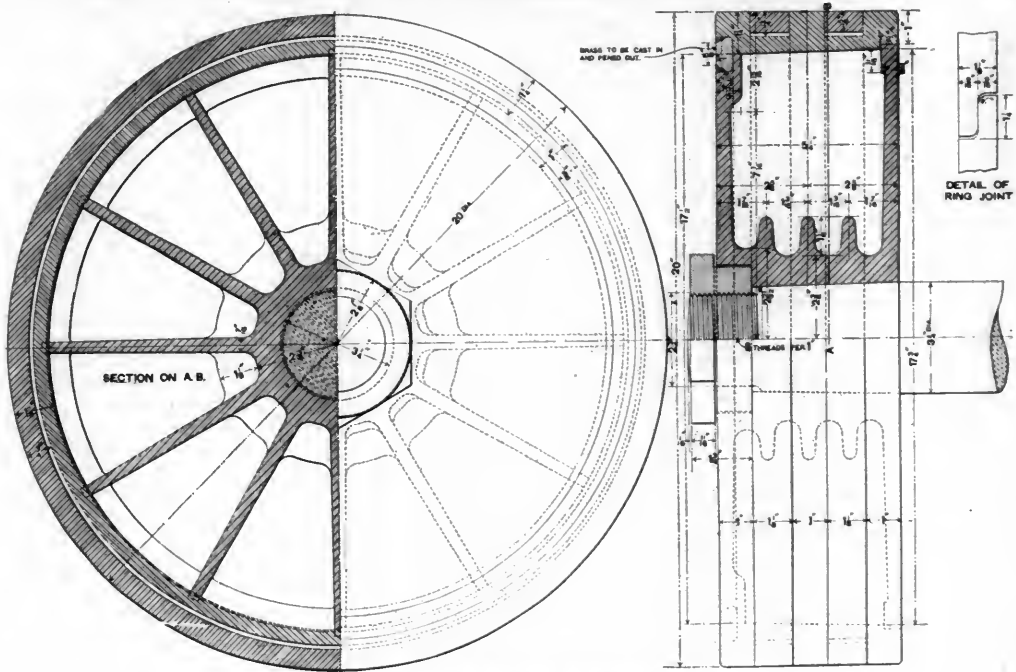
the means for determining what are the best forms for such wheels. Thus far those adopted appear to have been evolved by rule of thumb methods alone. It may be that the forms which have been used so long are weaker than was ever suspected, and that some other shapes would be much less liable to fracture. The test showed indubitably that heating the treads of the wheels subjected their plates and ribs to tremendous strains, and the only reason why the Altoona wheel did not break was that the material of which it was made had sufficient strength, elasticity, ductility, toughness, or whatever it is called, to resist these strains. It would seem to be the part of wisdom to make wheels, if it be possible, of a form which would not be subject to such strains when their treads are heated, as they were in the tests, or as they would be by the application of brakes. It would be interesting and possibly instructive to put wheels say in a lathe and apply brakes to them with the ordinary maximum pressure and then revolve the wheels at the speed with which they would probably turn in actual service. This would show whether the heating action of the brakeshoes has the same effect as the molten iron produces. This is an attractive field for investigation and one in which more knowledge is urgently needed.

The Altoona wheel foundry is well equipped with hydraulic cranes and other appliances. The wheels are now all made in contracting chill moulds which give a more uniform chill in the treads of the wheel than can be produced in any other way. The materials used for wheels are from 30 to 35 per cent. of charcoal iron, 15 per cent. of coke iron, 5 per cent. of steel and from 50 to 55 per cent. of old wheels. It is specified that the coke iron shall not have more than from 1 to 1.25 per cent. of silicon.

One machine in use in connection with the foundry was new to the writer. This was for brushing the sand from the wheels. It was made by the Northwestern Wheel and Foundry Company, of St. Paul, Minn., and consists of two iron discs of about the same diameter as the wheels, which are each mounted on the ends of horizontal shafts. Each disc overhangs the bearings of its shaft, which has a driving pulley and friction clutch for throwing in and out of gear. The discs face each other, and to the surfaces thus presented wire brushes are attached, and the wire strands project at right angles to the faces of the discs, the wires being parallel to the axis of the shafts. The latter have a certain amount of horizontal movement in their bearings, so that by means of levers the discs can be drawn apart and a wheel rolled between them. The discs are then made to revolve by belts on pulleys attached to the drafts, and the brushes are brought in contact with the two sides of the wheel, and all the sand is thus quickly brushed off from the exposed surfaces. That which adheres between the ribs is afterward brushed out by a cylindrical brush resembling somewhat a large paint brush attached to a flexible shaft driven by a pulley. The cost of cleaning wheels has been reduced three cents per wheel by the use of these machines.

Another interesting machine is a sand sifter made by the Walker Manufacturing Company, of Cleveland, O. This consists of a rectangular box, about 3 by 5 ft. and a foot or 18 inches high or deep, and with a sieve forming the bottom. This box is suspended by inclined, loose-jointed links or rods about 2 feet long attached at each of the four corners. Over the middle of the box is a bearing which receives the pin of a crank attached to a vertical shaft over it and driven by a pulley or belt. As the crank revolves the bearing is of course carried in the path of its pin and the box is carried with it. The latter being suspended by the inclined links the horizontal oscillation of the lower ends of the latter causes the corners of the box to rise and fall in sequence, as it were, which with, the movement imparted by the crank, produces a sort of squirming or wriggling movement admirably adapted for sifting the sand which is put into the box.

The brass foundry is also an interesting place and is well arranged and designed. The building is 36 by 80 feet, with a central stack, or chimney, and with 18 furnaces arranged circularly around it. This building is admirably lighted and well ventilated, and has capacity for melting ten tons of metal per day. An adjoining room contains appliances for lining car journal bearings with lead. The bearing surfaces of these are first cleaned with



Malleable Iron Piston—Norfolk & Western Railroad.

dilute acid, and are then tinned. After this operation they are clamped against a vertical cylindrical iron "core"—it may be called—having projections which leave a space of about one-eighth of an inch between it and the brass into which the melted lead is poured. As soon as the lead is set the fin, or superfluous metal, which projects is cut off by a kind of shear attached to the core. The whole process is quickly done. This lead lining is generally used on bearings for the Pennsylvania road.

In the use of brass bearings it was found that what may be called hard nodules were formed in the metal, which were not worn away with the other metal, but would often project from the surface and wear into and cut the journals. The formation of these nodules was finally attributed to oxidation on the surface of the melted brass while it was in the crucibles. A cure for the evil was found in sprinkling powdered charcoal over the surface of the molten metal while it is in the furnace.

An interesting annex to the foundry is the boiler room. In this three large Bellpaire boilers of the locomotive type have been installed, with room for an additional one. The level of the engine-room is about five feet below a track which extends into it and is supported on posts or trestle work. The track runs transversely to the boilers and is about eight or ten feet back of them—speaking in locomotive parlance. The coal is brought in on drop bottom cars and dumped on this trestle. It is then within convenient distance for firing the boilers, and is placed in that position without any other labor than that of running the cars in and dumping them. In front of the fireboxes of the boilers is a transverse pit, or what might be called a ditch, which has a bucket, which runs on a track on the bottom of the pit. This bucket can be placed in front of the ashpan of any of the boilers and the ashes can be raked directly into it. Between two of the boilers is a lift which consists of an inclined runway extending from the ashpit backward over the track on which the coal is brought in. This runway has a wire rope operated by a horizontal cylinder and pulley under the roof. To remove the ashes, a car is run in on the track to receive them, and the bucket is then filled and brought to the foot of the runway, the wire rope is attached to it, water is admitted to the cylinder; the bucket, which has a drop-bottom,

is carried up and over the car, when it is dumped and the ashes deposited in it without any other labor than is here described. The hydraulic cylinder and piston is operated by a pump and accumulator in the usual way. Adjoining the boiler room there is also a Clayton air compressor which supplies air to various appliances inside and outside the foundry. One of them is an air lift or hoist for loading and unloading cars. This consists of two posts about twenty feet high and placed about thirty feet apart with a transverse beam on top, to which a vertical cylinder with about ten-feet stroke and perhaps twelve inches diameter. The piston rod can readily be attached to any object which is thus raised by the admission of air to the cylinder.

A steel rail breaker is also an appendage to the foundry. This consists of a large hydraulic cylinder, somewhat like those used for hydraulic riveting machines, the piston of which works horizontally. The rail is placed between the ram and suitable bearings, and when water pressure is admitted the rail is broken almost like a pipe stem. The rails are reduced to short pieces to facilitate putting them in the cupola when they are mixed with the iron for the manufacture of wheels.

(To be Continued.)

Malleable Iron Locomotive Piston.—Norfolk & Western Railroad.

The Norfolk & Western Railroad has recently put into service a number of locomotive pistons, in which the head is of malleable iron, with an outer rim of cast iron. Through the courtesy of Mr. R. H. Soule, Superintendent of motive power, we have received the working drawings from which the accompanying engravings were made.

The head proper consists of a single casting of malleable iron, having a central hub $4\frac{1}{2}$ inches in diameter, and front and back plates or walls ranging from $\frac{3}{8}$ to $1\frac{1}{2}$ inches thick. Twelve radial ribs, from $\frac{7}{8}$ to $1\frac{1}{8}$ inches thick, extend from the hub outward and three circular ribs strengthen the hub. The casting resembles the ordinary "solid" piston except that it is open at the rim. This opening is closed by a cast-iron ring $1\frac{1}{2}$ inches thick, and the full width of the piston head, namely, $5\frac{1}{2}$ inches. The fit for this ring

is made slightly conical, being, on this 20-inch piston, 17½ inches at the front face and 17¼ inches at the front of the back wall, at which point there is a shoulder, and the diameter is enlarged to 18 inches. The ring is put on from the front and forced against this shoulder; it is then held in place by casting a brass ring into the dovetail groove in the front face of the piston. The brass ring is hammered down until it fills the groove tightly. The packing rings are cast-iron spring rings, 1½ inches wide and ⅝ inch deep.

The advantage of this construction lies in the fact that a light-weight piston is obtained, and yet cast iron, with its unexcelled wearing qualities, is retained for the surface in contact with the bore of the cylinder. The retaining ring for fastening the rim is a neat way of avoiding the use of bolts or rivets. The actual saving in weight over a cast-iron piston is shown in the following figures:

Type of piston.	Weight without packing rings.	Weight with packing rings.
Standard (cast-iron box).....	237.5 pounds	280 pounds.
Composite.....	187.5 "	210 "

This shows a saving of 70 pounds if the composite piston is compared with the company's old standard piston. The officials believe that a further reduction of from 10 to 30 pounds can be effected in this design.

New York Central Locomotive No. 923.

A new anthracite coal burning locomotive has just been completed at the West Albany shops of the New York Central Company and has been put into service on the Hudson River division of the road. It is of the American type with 78-inch wheels and 18½ by 22-inch cylinders. The firebox is 103 inches long, and is placed on top of the frames and has a water-bar grate, which inclines downward toward the front. The springs and equalizing levers are below the driving-boxes, the latter being made of Ajax metal. The crown sheet is slightly arched and is supported with crown bars with a wagon top over them. The firebox rests on expansion links pivotally connected to the frames and to the boiler.

The general design and finish of the engine is similar to the celebrated 999. Nearly all the parts which were susceptible of it are brightly finished and polished, the fixtures in the cab being nickel-plated. Many of the bolt heads, as in the guide bars, smokebox and boiler braces are counter-sunk so as to make a smooth finish. The oil cups on the guide-bars are forged solid with them with tight fitting covers. The cylinder oilers have a self-measuring attachment by which a definite quantity of oil can be applied at each oiling.

The firebox has Mr. Buchanan's furnace door with an inside deflector, which has worked so satisfactorily on this road. As the trailing driving-axle is under the firebox, the ash-pan must be arched over it. It consists of two deep, hopper-shaped receptacles, one in front and the other behind the rear axle, and have sliding doors at the bottom which are operated by a vertical shaft, which extends upward through the foot-plate, and has a lever on its top end. When the doors are opened this must be turned outward and projects over the foot-plate behind the firebox, and is thus in the way of the fireman. When the doors are closed the lever is moved forward and then stands transversely to the engine, close to the firebox, and is then out of the way. The projection of the lever over the foot-plate is thus a reminder to the fireman that the doors are open, the object being to have them always closed when the engine is on the road. An opening is provided in the front of the ash-pan at some distance above the rails for the admission of air.

The tank is provided with a gage on the front end. This consists of a vertical iron pipe connected to the bottom of the tank, and with a cock in the connection. A number of small holes are drilled at close intervals along the whole length of the iron pipe. When the cock is opened water flows out of these holes, and thus shows how high the water is in the tank. The iron pipe has the advantage over a glass gage, that there is no danger of breaking it.

The apron which covers the interval between the foot-plate and

tender is covered with sole leather, fastened with rivets, which gives a secure foothold for the fireman.

The driving truck and tender wheels all have cast-iron centers and steel tires fastened with retaining rings.

Another feature which has been very extensively adopted on new engines for this road is the extended piston rods. These project through the front cylinder-head, and are then supported by a guide and inclosed by a casing outside. It is reported that this device lessens the wear of piston packing and cylinders to a very great extent.

The connecting and coupling rods are fluted, the latter have solid bushed ends and the former stub ends, front and back, the straps being fastened with three bolts.

The hand-rails and hand-holds are covered with Russia iron, which is a new device.

The engine is equipped with monitor injectors, chime whistle and Gould's automatic couplers, at the front of the engine and back of tender. The engine and tender are both painted black, with silver striping. Excepting in some of the switching engines, we believe this is the first instance of the use of anthracite coal on the New York Central road. This one is intended for service on the trains between New York and Poughkeepsie.

The finish of the engine surpasses—if that is possible—that of the 999, and is an example of the best and most recent practice in American locomotive engineering.

Admission of Apprentices and Mechanics to the Engineering Courses of Purdue University.

In response to numerous inquiries in regard to the admission of experienced mechanics to the Engineering Courses, the President of Purdue University has published a statement embodying the practice of the University in such cases.

The courses in Mechanical, Civil and Electrical Engineering include lines of work such as carpentry, pattern-making, molding and casting, forging and machine work, with which shop men are often familiar, and for this reason such men may enter these courses under conditions which are greatly in their favor. Thus those who, as apprentices, have acquired skill in manipulation and have become acquainted with the principles of construction, can properly be excused from the shop work which other students are required to take; the experiences of the shop can in this way be made to count in advancing the student in his professional course. Or if it happens that an applicant is unprepared in some line of work required for admission, such deficiency need not prevent his admission, provided his credits in shop work are sufficient to give him time in which to bring up the required preparatory work.

Each application for credit or for conditional admission will necessarily require individual consideration, and persons seeking such admission are advised to inform themselves by correspondence before going to the expense of applying in person. The important conditions, however, governing the admission of persons having credits and conditions are indicated in the following statements:

1. Each applicant for admission who desires credits in shop work must present a statement in his own handwriting setting forth his shop experience, which statement should be indorsed and approved by the superintendent of the shop or shops in which he has worked.
2. Three years' experience as a regular apprentice or as a journeyman in an approved shop will be accepted as a complete equivalent for all shop work required by the college course. It is equivalent to a credit of nine hours per week for two years. An experience of less than three years may be accepted as an equivalent for a portion of the shop work required in the course.
3. Applicants for admission who can show that they are entitled to credits in shop work, but who are unable to pass entrance examinations, will be admitted conditionally if their general attainments indicate that they are likely to become successful students; but such applicants should not be less than twenty years of age.
4. Students admitted as freshmen, with credits in one or more lines of college work and with conditions in preparatory subjects, will be given regular instruction in the subjects in which they are deficient.
5. Students admitted with conditions will be required to pursue such lines of study in some one of the three courses named as will tend to make them regular. Special courses of selected studies will not be granted.

The Pennsylvania Avenue Subway and Tunnel in the City of Philadelphia.

The abolishment of grade crossings in large cities presents to the engineer many complicated problems for solution and involves the expenditure of millions of dollars. In some cases easy grades on the streets and the railroads, the minimum damage to adjacent property, economy in expenditure and a non-interruption of traffic are the chief problems, and even then the work is not an easy task. But when the railroad tracks whose grades are to be altered are connected by sidings to numerous manufacturing and industrial establishments, warehouses and elevators, and as a result of the improvements are found to interfere with existing water, gas and sewerage systems, the difficulties are vastly increased. Such is the situation which the engineers in charge have had to meet in preparing the plans for the new subway and tunnel for the Philadelphia & Reading Railroad in the city of Philadelphia.

Several years ago the railroad company completed its handsome terminal station, and the elevated approach to it, by which a number of dangerous grade crossings were avoided. But leading from these terminal tracks is a line running at grade through Pennsylvania avenue and crossing many streets. On each side of it are large industrial establishments, some of them of world-wide reputation, and all doing a large business, such as Wm. Sellers & Company, Baldwin Locomotive Works, Bement, Miles & Company, Whitney & Sons, and others. The constant switching of cars made the location so dangerous that finally the city authorities and railroad company mutually agreed to lower the tracks, the cost of the work to be shared equally by the two corporations. Accordingly an ordinance was passed by the City Council in March, 1894, accepted by the railroad company, and the work of preparing the plans placed in charge of the city's engineering department. The estimated cost of the work is \$6,000,000, and upon its completion seventeen grade crossings will be abolished and the entrances to Fairmount Park relieved of objectionable features.

These plans are now complete, and such changes as were necessary in the sewage system of the city have already been made. During the past month the city has been receiving bids from contractors, and the work will be given out at an early date and construction pushed rapidly. The tracks will be lowered on the average 25 feet below the surface of the streets, and the total length of the right of way, the grade of which is altered, is 10,000 feet, of which 2,912 feet is tunnel, 6,038 feet is open subway, and the remaining 1,060 feet is elevated structure. Besides the sidings leading to industrial establishments, there are two freight yards adjacent to the main tracks which must also be depressed, one between Thirteenth and Sixteenth streets and the other at Twentieth street, where an engine house, coaling station and turntable are also located. The open subway is wide enough for from four to six tracks, and the tunnel is to contain four tracks. It is evident, therefore, that the work is one of great magnitude.

On page 96 we have reproduced a perspective of the work as it will appear when finished, and on this view is designated the location of a number of important manufacturing plants, most of them well known to our readers. On page 97 is given a plan of the subway and tunnel, with sections of both, and Figures 3 and 4 on page 99 give additional sections that are of interest.

The plans provide for a very slight change of grade at Twelfth street, the railroad being carried over it as at present. Beginning at Twelfth street the tracks continue on a down grade of 2½ per cent. to a point just beyond Broad street, where the grade is eased off to .8 per cent., which continues for about one and one-half blocks, after which the tracks are practically level to the portal of the tunnel. At Thirteenth street the tracks will cross at about the present grade of the street, requiring the latter to be depressed considerably, but this is the only street whose grade is changed materially. From Thirteenth to Sixteenth streets the entire space between the north side of Callowhill street and the north side of Pennsylvania avenue is to be excavated to form a depressed freight yard for the railroad com-

pany. All streets from and including Broad street to Twentieth street are to be carried over the subway on bridges. This portion of the work to the portal of the tunnel presents the greatest difficulties, because of the numerous sidings and the fact that the retaining walls will come so close to the building lines as to require the underpinning of many buildings and the reconstruction of their foundations. Fortunately it has been found possible to reach all sidings which must be kept open by means of temporary tracks that will be laid through Hamilton street east from Pennsylvania avenue, thus leaving the contractors comparatively free to carry on this section of the work.

The connection to Baldwin Locomotive Works, near Broad street, and the warehouse across the way, near Sixteenth street, are each to be made by a five per cent. grade. Near Sixteenth street several tracks cross over the subway on a bridge, thus allowing an engine to place cars on either side of the right of way. Between Seventeenth and Eighteenth streets another connection is made to the Baldwin Locomotive Works, the maximum grade being five per cent., as before. These grades are indicated in the profile of Fig. 2. Between Nineteenth and Twentieth streets a grain elevator is reached by a four per cent. grade, and west of Twentieth street a five per cent. grade leads to the Knickerbocker Ice Company's building. Connection to Bement, Miles & Company is to be made on the lower level, and the company will have a lift on its own property. The necessity for such steep grades leading to sidings arises from the short blocks. It is evident that each of these inclines must rise from the subway to the surface in less than the length of a block, and, as the blocks average considerably less than 500 feet long, the grades must be heavy.

Between Sixteenth and Eighteenth streets the firms of Wm. Sellers & Company and A. Whitney & Sons each have track connections, and to reach these parties a hydraulic lift is to be placed on the south side of the subway. It is seen in the perspective view, partly raised, and is also designated in Fig. 2 close to the Eighteenth street bridge. This lift is to be an immense affair, 155 feet long, and capable of carrying a locomotive and three loaded cars, making a total load of 320 tons, to be raised 26 feet. The great length of the table, and the fact that the load may be concentrated at almost any point on it, make the construction of this lift a very neat problem. The specifications for it do not impose any restrictions on bidders other than those inherent in the problem, the engineers in charge wisely concluding that these in themselves were difficult enough.

A commercial coal conveyor is to be located near Fifteenth street, and a power house south of the tracks between Eighteenth and Nineteenth streets will furnish hydraulic and electric power and light at various points along the subway and tunnel.

The triangular yard between Twentieth street, Hamilton street and Pennsylvania avenue, now occupied by the railroad company, is to be excavated, and will contain an engine house, a small repair shop, a coaling station with conveyors for ashes and coal, a freight house with hydraulic lifts, a 65-foot turntable and a 50-ton electric traveling crane of 43 feet 10 inches span, serving two tracks and capable of unloading direct from the cars to a roadway on the street level. Altogether quite a large and interesting plant is installed in this depressed space.

The tunnel begins just west of the above-mentioned yard. It consists of a single span of 52 feet, with a rise of 8 feet 8 inches, and is to contain four tracks. The arch is of brick and the tunnel is one of the widest of its kind. Its length is 2,912 feet, and a considerable portion of it parallels the two-track Baltimore & Ohio Railroad tunnel. The western portals of the two tunnels are in close proximity. A section of the tunnel is given in Fig. 2, and Fig. 3 is a section through the two tunnels, showing their relation to each other and also giving an idea of the ventilating arrangement for the new tunnel. Owing to the heavy traffic contemplated and the large dimensions of the tunnels, an elaborate system of ventilation has been provided with exhaust fans and fresh air intakes. West of the tunnel the tracks will be carried in an open subway on an ascending grade of 1.3 per cent. to the present level of the track at Thirtieth street. Footway bridges will be

FIG. 1—PERSPECTIVE VIEW, SHOWING PENNSYLVANIA AVENUE SUBWAY AND TUNNEL AS IT WILL APPEAR WHEN COMPLETED

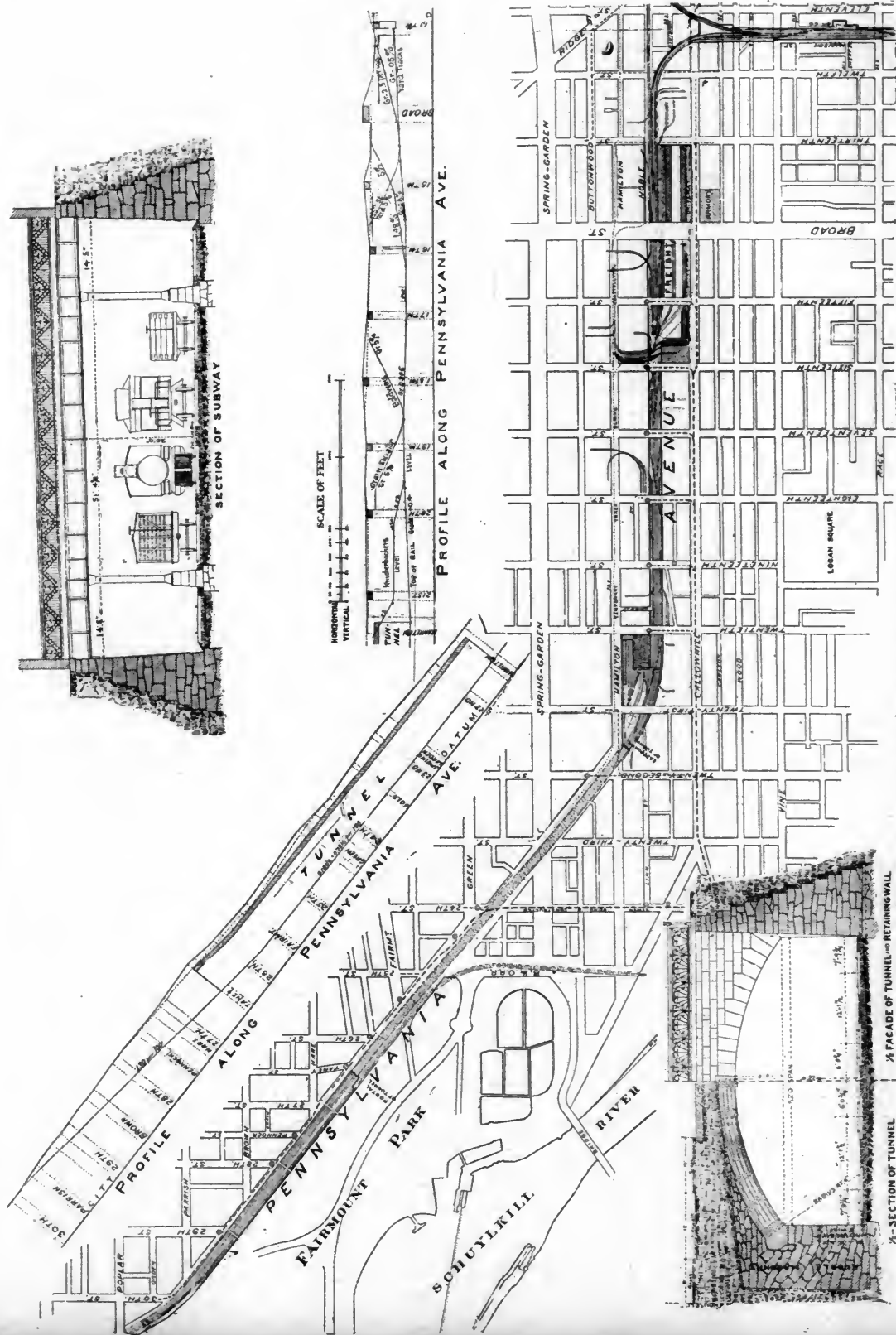


FIG. 2. PLAN, PROFILE AND SECTIONS OF PENNSYLVANIA SUBWAY AND TUNNEL.

carried over the subway at Twenty-seventh, Twenty-eighth and Twenty-ninth streets.

In Figs. 2, 3 and 4 are given sections that are each typical of the masonry work. The tunnel section we have already alluded to; the dimensions of the retaining walls are given in Fig. 4; if at any point it is of greater height than shown the wall is carried down with steps of 18 inches every 4 feet as shown. The section of a bridge abutment is likewise typical. The section showing the relation between the retaining wall and the foundation of adjacent buildings that must be under-pinned during construction is only one selection from many cases. In some instances the entire front of buildings must be removed and rebuilt. The retaining walls are to be built in an open trench, and are to be of rubble masonry laid in Portland cement (1 part cement to 3 parts sand), with a coping 10 inches thick. After the completion of the walls the core of earth between them will be removed, that work being a separate contract.

In the construction of the tunnel the tracks will be thrown first to the one side of their present location and then to the other side, to permit of the construction of the side walls. Then after the removal of the core the arch will be constructed. The side walls are to be of large rubble masonry laid in Portland cement of the same quality as for the retaining walls. They are to have refuge bays in them at regular intervals. The brick arch is to be laid in natural cement mortar and terminated at the ends by stone voussoirs. The entire surface of the extrados of the arch and over the spandrel filling is to be plastered with natural cement mortar $\frac{1}{4}$ inch thick.

The ventilation of the tunnel will be accomplished through two fan stations on the north side of the tunnel, one located near Twenty-third street and the other between Twenty-fifth and Fairmount avenue. Each station is to have two large slow-moving fans, driven by electric motors, each of a capacity of 150,000 cubic feet per minute, or a total of 600,000 cubic feet for the four. They will be able to remove air equivalent to the total volume of the tunnel every five minutes. Into these fan houses conduits enter from both directions. Each has four openings into the tunnel of 35 square feet area, and the conduits begin with a diameter of 6 feet 6 inches at their further ends and increase to 11 feet at the fan houses. One of these is seen in the section in Fig. 3. On the south side of the tunnel ten fresh-air intakes are provided. They are not located directly opposite the exhaust openings, as might be inferred from Fig. 3, but at intermediate points. The openings for the intakes are covered with cast-iron gratings. The exhaust conduits are to be of brick laid in natural cement mortar, with a cradle of rubble masonry or concrete. The arch generally is to be 18½ inches thick and the invert 4 inches. At the exhaust openings they are to be bonded into the brick tunnel arch and the lines of intersection of the cylinders formed by the opening and the arch are to be constructed of fine pointed cut stone.

The highway bridges built over the subway at various points are all of the plate girder deck type, with solid floors covered with concrete, on which is laid 3 inches of asphalt. Where the street is on a heavy grade, the roadway is to be paved with vitrified brick instead of finished with asphalt. The railroad bridges are also to be of the same type, with solid floors, covered with ballast.

As already stated many new sewers had to be laid preparatory to the construction of the main work. Altogether 3½ miles of sewer varying from 12 inches to 10 feet 6 inches in diameter have been laid at depths of from 20 feet to 40 feet below the surface of the streets, at a total cost of about \$500,000. In order to cause the minimum of inconvenience 65 per cent. of the sewer work was constructed in tunnel.

The engineering difficulties in the construction of a work of such magnitude are many and various. Among the most serious in the present instance may be mentioned the work of under pinning, and supporting the many large buildings, warehouses and elevators while the excavation is carried on practically beneath the foundations, and the masonry retaining walls built. The blasting of the rock near such structures requires the utmost care and good judgment. Special machinery for excavating

will be required, and water and gas pipes and electrical conduits must be taken care of.

As already stated, the Department of Public Works of the City of Philadelphia has prepared all plans and specifications. The officials in charge of the work are: Mr. Thomas C. Thompson, Director of the Department of Public Works; Mr. Geo. S. Webster, Chief Engineer, Bureau of Surveys; Mr. J. M. Wilson, Consulting Engineer, P. & R. R. Co.; Mr. G. E. Datesman, Principal Assistant Engineer, Bureau of Surveys; Mr. S. T. Wagner, First Assistant Engineer, in charge of the work; Mr. R. I. D. Ashlidge, Second Assistant Engineer, in charge of construction; and Mr. Chas. H. Swan, Chief Draughtsman.

Should a Railroad Adopt Electric Motive Power to Meet the Competition of Electric Suburban Lines?

To what extent a railroad shall strive to retain the traffic which electric lines, actually constructed or contemplated, will otherwise take from them, is a question which a number of railroad companies have already had to consider. It is ably discussed in the twenty-seventh annual report of the Massachusetts Railroad Commission (issued under date of January, 1896), in a chapter devoted to electric motive power. In the same chapter the status of electricity on steam roads is also discussed, and while the conclusions of the Commission may not differ from those of other thoughtful students of the problem, they are so well expressed that we quote from them. The Commission says:

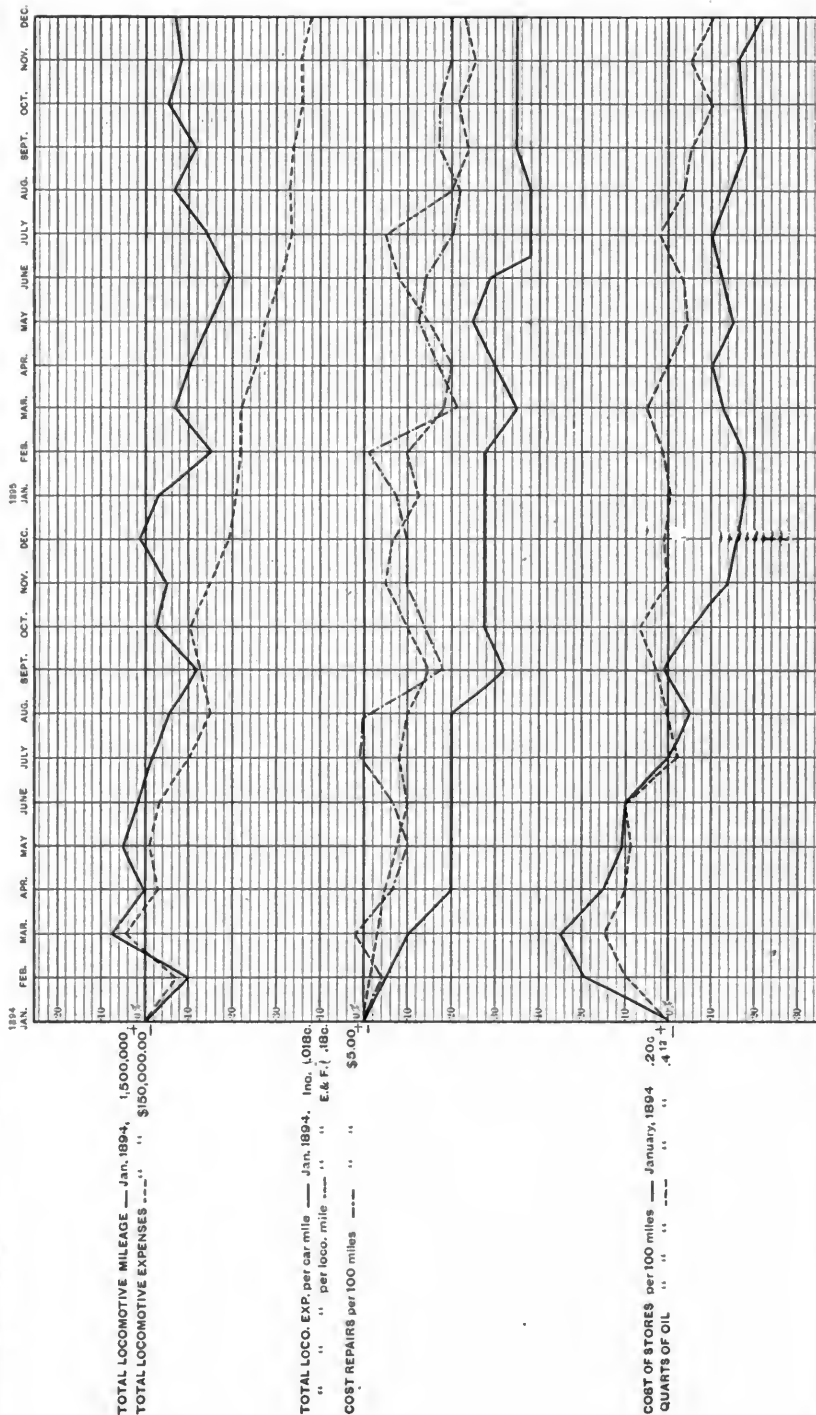
"Whether, taking everything into account, it is as practically convenient and economical to generate at a central station the power of 20 steam locomotives, and by the electrical distribution of this power over the lines of a railroad to move that number of trains, as it is to distribute over the lines 20 steam locomotives, each generating its own power, to haul the trains, is the gist of the question which is at issue between steam and electricity as the better motive power for general railroad operation.

"This question does not as yet admit of a categorical and unqualified answer. In the present stage of electrical development, and in the light of such experience as has been had in the actual use of electric power in railway and railroad operation, the most definite answer that can be given, or that has been given by experts and practical railroad men, amounts to this: The more closely a given railroad service resembles in character that of the ordinary street railway, the better the adaptation to that service of electric motive power; and, conversely, the less the resemblance, the poorer the adaptation. In other words, the most efficient and economical use of electric power will be found where there is a considerable and steady volume of local and short-distance travel, which requires or justifies the running of numerous light passenger trains, at short and regular intervals, so that the trains will be constantly and uniformly distributed over the railroad line. The most efficient and economical use of steam power, on the other hand, will be realized where the traffic is concentrated in heavy trains, run at infrequent and irregular intervals, in accordance with the usual method of conducting through or long-distance transportation.

"In passenger traffic, the public demand and the railroad policy have been in the direction of more frequent and quicker trains. In freight service, on the contrary, where there is no such pressure or occasion for frequent trains at high speed, the policy has been in the direction of fewer and heavier trains. The whole tendency of modern railroad development has been to cut down grades and to increase the weight of engines and of trucks, so as to enable a single locomotive to haul a heavier freight train load. It has been estimated by good authority that doubling the number of engines for a given traffic increases the cost of transportation about 50 per cent. The general tendency of passenger traffic may therefore be said to lie in the direction in which electricity is the most serviceable, while the reverse is true as regards freight traffic.

"With respect to speed, extraordinary claims are made by those interested in the development of electric traction, but there is no question that the steam locomotive is fully capable of developing as high a speed as it is desirable or prudent to use. A railroad speed of 100 miles or more an hour is, for the present purpose, a matter of merely curious speculation. It cannot be shown that there is enough traffic demanding this speed to pay the excessive expense of operation, even if with present methods of construction and equipment it were otherwise at all practicable. Before any such speed is seriously thought of, there must be radical improvements in safety appli-

LOCOMOTIVES: Cost of Operation.



A GRAPHICAL METHOD OF RECORDING LOCOMOTIVE EXPENSES.

"If the diversion of short-distance traffic were likely to cripple the resources of the railroads, the question would have for them a more serious import. We anticipate no such result. The disturbing element is not of recent origin. It began with the horse railway; and it is now some seven years since the electric railway has been fastening upon this traffic its farther reaching and more tenacious grasp. Meanwhile, up to the inception of the recent business panic, the traffic and revenues of our railroads kept on rapidly growing year by year. But for the exceptional stringency of the times, there is no reason to doubt that they would have continued steadily to increase. With only a partial recovery from general commercial depression, the net earnings of our railroad companies were larger the last year than in any previous year in their history.* With years of returning prosperity we venture to predict that their traffic and revenues will grow in the future as they have grown in the past.

"Whatever the diversion of short-distance travel, the increase of population and industry which the electric railway will foster and develop along the railroad lines, will still be tributary to the latter in a hundred ways.

"It is, perhaps, unnecessary to add, that there is no apparent demand by the public for the substitution of electricity for steam in general railroad operation. No complaint has come to our ears that the present railroad service, so far as the motive power is concerned, is inadequate or unsatisfactory. The question, as it now stands, is one purely of economy, to be decided by the railroads primarily in their own interest, bearing in mind, as they will, that it is always for their interest to give to the public the best service reasonably in their power. Our railroad managers, we have reason to know, are giving to the subject their diligent attention and study; and they will be alert to introduce the new motive power upon their lines so soon as it shall become manifest that by so doing they can give to the public a substantially cheaper and better service."

The Use of Graphical Methods in Keeping the Accounts of Railway Mechanical Departments.

The value of the graphical method of recording and comparing statistics of various kinds is so generally recognized that its use is daily extending. It has frequently been used in railroad circles, but until recently we have not found it employed systematically and regularly in recording the various monthly expenses of a mechanical department. Such a use of graphics on a large railroad system entering Chicago recently attracted our attention, and through the kindness of the superintendent of motive power, we have been furnished with interesting particulars. We have been asked not to name the road from which our information is obtained, but a few of our readers in official positions have already investigated the workings of the system, and have been charmed with it, and we can probably put others on the track of any additional information they may require.

In establishing the graphical records on the road alluded to, the expenses for the month of January, 1893, were taken as a basis, and the percentage of increase or decrease in each item was calculated and shown graphically. Three separate sheets were decided upon, one for shops, one for cars and the third for locomotives. Not more than three items are grouped under one set of lines, though there may be several such groups on the one sheet or chart. On the sheet for the shops is shown the total locomotive mileage, the total car mileage, the total material received, the total material charged out, the material on hand, the total shop labor, excluding engineers' and firemen's wages. Under the heading of cars is shown the passenger car mileage, the cost of passenger car repairs per mile, the cost of passenger car lubrication per 1,000 miles, the cost passenger car cleaning per car; the total freight car mileage, freight car mileage loaded, freight car mileage empty, cost of freight car repairs per mile, and cost of freight car lubrication per 1,000 miles. Under the sheet for locomotives is given the total locomotive mileage, total motive power expenses including engineers' and firemen's wages, the total motive power expenses excluding engineers' and firemen's wages, the total locomotive expenses, total locomotive expense per car mile, total locomotive expense per locomotive mile, cost of repairs per 100 miles including new locomotives, cost of locomotive repairs per

100 miles excluding new locomotives, cost of fuel per 100 miles, pounds of coal per passenger car mile, pounds of coal per freight car mile, cost of lubrication per 100 miles, quarts of oil per 100 miles, passenger and freight, and cost of stores per 100 miles.

The records are kept on tracing cloth 22½ by 44 inches, ruled like profile paper. These tracings are filed in the drawing room and kept up to date by the draftsman through information furnished him each month.

In the illustration on page 100 we reproduce a part of the locomotive sheet showing seven of the items mentioned. It is a facsimile as far as the general arrangement is concerned, but the values given are fictitious, although approximate, and they refer to January, 1894, as a basis. The diagram is ruled with vertical lines representing the months, and at each group of items there is a heavy horizontal base line with parallel rulings above and below it, for each two per cent., those above representing increase and those below, decrease. The percentage of increase or decrease for each item is laid off on each monthly line, and the points connected with a line of a character designated on the left-hand margin. Thus the locomotive mileage which in January, 1894, was 1,500,000, was 10 per cent. less in February, and 8 per cent. more in March of the same year. In December, 1893, it was 7 per cent. less, while in the meantime the locomotive expenses decreased nearly 38 per cent.

In the same way we are shown in a striking manner the falling off in the cost of repairs, in the cost of stores, and in the locomotive expenses per car and per locomotive mile. It needs no argument to convince any reader that the expenses of the department are shown up in a more comprehensive manner by this graphical method than can possibly be done by the use of tables of figures, however carefully they are prepared. This graphical system is worthy of extensive use in mechanical departments, and where adopted it might lead to economies, the need for which is not at present realized. In our example the falling off in expenses is of course to be largely attributed to the temporary retrenchment which that road in common with others has had to practice in the last two years.

CONTRIBUTIONS TO PRACTICAL RAILROAD INFORMATION.

Chemistry Applied to Railroads.—Second Series.—Chemical Methods.

XVIII.—Method of Determining the Fineness of Grinding of Freight Car and Passenger Car Color.

BY C. B. DUDLEY, CHEMIST, AND F. N. PEASE, ASSISTANT CHEMIST, OF THE PENNSYLVANIA RAILROAD.

EXPLANATORY.

In the purchase of paints there is always a question in the mind of the consumer as to the fineness of the grinding. And since it is well known that not only the satisfactory working of the paint under the brush, and the appearance of the surface when the painting is finished, but also the durability of the work is affected by the fineness to which the paint has been ground, it is obvious that the grinding of paint is an important matter. Moreover, as paints are ordinarily ground, from 10 to 20 per cent. of the price of the paint is for the grinding, and as it would be easy by insisting on much finer grinding to increase the cost 20 to 30 per cent., it is clear that the financial side of paint grinding is not its least important phase. Several methods of determining the fineness of grinding have been proposed. One of these is to put a little of the paint on one thumb nail and rub it with the other. If there is no scratching or gritty feeling the paint is supposed to be finely enough ground. Experience shows, however, that both the nature of the pigment, and the nature of the menstruum used along with the pigment, as well as the individual characteristics of the operator, all affect this test, so that its indications cannot be regarded as sufficiently reliable to be of much value. Another test is to mix with the paint quantities of some liquid which dissolves the menstruum completely, and does not dissolve the pigment, and then see if the whole mass, pigment and liquid together, will run through a sieve which has been decided on as the

* This, of course, refers to the railroads in the State of Massachusetts.—EDITOR.

standard of fineness. For example, if 100-mesh or 150-mesh sieve has been decided on as the standard of fineness, it is obvious that if part of the pigment is left on the sieve, the paint was not finely enough ground. Still another test of similar nature is to separate some of the pigment from the menstruum and examine the dried pigment under the microscope, measuring the size of the particles if desired. It is obvious that both these tests simply tell something in regard to the fineness of the pigment. They do not give any information as to how well the pigment is mixed with the menstruum, which is one of the important elements in the grinding of paint. Indeed, experience shows that with either of these tests it would be quite possible to pass paint as well ground which had never been in a mill at all, it having been simply mixed in a "chaser." Moreover, it is very difficult to get a sieve which even approximates in mesh the fineness desired in well-ground paints. Also in the microscope test there is very great difficulty in being sure that aggregations of particles are not being measured instead of the particles themselves. In view of these difficulties, it is clear that there is need for some test which shall be definite and positive, which shall give results always alike, which shall be unaffected by the individuality of the operator, and which shall tell what it is essential to know, viz: (1) That the particles of the pigment are themselves sufficiently fine, and (2) that they are properly mixed with the menstruum. It is believed that the test which is described below accomplishes these results in a satisfactory manner. The test is described as applying to paints purchased in the paste form only. It is thought, however, that the principles involved in the test being made clear, modifications of the method can readily be made which will make it applicable to all kinds of paints, with the possible exception of those in which the proportions of pigment to liquid are outside the limits of the test.

OPERATION.

Weigh into a small porcelain dish in the case of freight-car color two (2) grammes of the paste, and add one (1) gramme of pure raw linseed oil, and in the case of passenger-car color five (5) grammes of the paste, and add three (3) grammes of pure raw linseed oil. Stir with a glass rod having a rounded end, until the material is a homogeneous mass. Have ready the cooling chamber and the strips of glass described below, which have been brought to a temperature of 70 degrees Fahrenheit by passing warm or cool water through the cooling chamber. Place the dish containing the material to be tested in the cooling chamber, and allow it to stand half an hour. Then stir thoroughly again and with the glass rod place a few drops of the material on one end of one or more of the strips of glass, place the glass vertically in the cooling chamber, with the end containing the spot of paint uppermost. Replace the cover and allow it to stand for half an hour. The material runs down the glass in a narrow stream. At the end of the time remove the cover, and examine the strips of glass, best by holding them between the eye and the light. If the liquid has not separated from the pigment for an inch down from the top of the test, that is, if the stream of paint is smooth, continuous and completely opaque for this distance, the paste is sufficiently fine ground. On the other hand, if the liquid has separated from the pigment, leaving little patches and ridges of pigment, and apparent rivulets down which the liquid has passed, leaving more or less pigment behind, the stream of paint being more or less rough and irregular on its surface, and more or less transparent, the paint is not sufficiently well ground.

APPARATUS AND REAGENTS.

Any convenient porcelain dish will do for the mixing of the paste and oil. One 2½ inches in diameter across the top and 1 inch deep does nicely.

The cooling chamber may perhaps best be described as one metallic box inside another one, the spaces between the two being filled with water of the proper temperature, and the inside box being fitted with a cover. In order to make the construction clear, let us describe as follows: Make a completely closed box of sheet copper 10 inches square and 8 inches high. In the top cut a hole 6 inches square. Into this hole slip another sheet-copper

box, 6 inches square and 6 inches deep, but without a top. Make all joints tight. Fit the 6-inch box with a removable cover. Make two holes, half an inch in diameter, in the top of the larger box to serve as inlet and outlet for the cooling water, and into one of which a thermometer may be placed to take the temperature of the water. It will be seen that we thus have the inside box as a cooling chamber, surrounded on five sides by a layer of water approximately 2 inches thick. The cover being placed on the smaller box, it is evident that the space inside the smaller box, or any articles placed in it, will, after a proper time, become very closely the temperature of the layer of water. If now this is adjusted to 68 or 69 degrees Fahrenheit, the temperature of the chamber will be very near to 70 degrees Fahrenheit, the desired temperature, if, as is customary, the apparatus is used in a room or laboratory which is kept from 70 to 80 degrees Fahrenheit.

The strips of glass used are about an inch wide and 4 inches long. They should be dry and before use should be brought to the same temperature as the cooling chamber, by standing them vertically around the sides of the chamber for at least half an hour.

The linseed oil to be mixed with the paste should be pure raw oil, and should not be allowed to get old.

CALCULATIONS.

The results of this method being simple observations, no calculations are required.

NOTES AND PRECAUTIONS.

It is evident that this method depends for its success on the fact that a moderately viscous liquid like linseed oil does not separate from particles of solid matter, under certain conditions. The principal conditions which have been found to affect the test are as follows: 1st, the temperature; 2d, the proportions of pigment and liquid; 3d, the nature of the liquid; 4th, the nature of the pigment; 5th, the completeness with which pigment and liquid are mixed, and 6th, the fineness of the pigment. It is not claimed that no other conditions affect the test, but these are believed to be the principal ones.

It is obvious that by increasing or diminishing the temperature at which the test is made, the viscosity of the liquid is increased or diminished, with consequent increase or decrease in its ability to leave the pigment. The higher the temperature, the more limpid the liquid, and the less its likelihood of staying with the pigment.

The proportions of pigment and liquid have a very important influence on the test. Indeed it is this variable which is generally used in applying the test to various kinds of paints. The proportions given under "Operation," as applying to freight-car color, are different, it will be observed, from those applying to passenger-car color. These proportions are determined by experiment, and may be different for every kind of paint, depending on the nature of the pigment, the nature of the menstruum in which the pigment is ground, the temperature at which the test was made, how completely the pigment and liquid are mixed, and especially the fineness desired. The standard freight-car color of the Pennsylvania Railroad Company is a mixture of about 75 per cent. pigment, with 25 per cent. of pure raw linseed oil, both by weight. The pigment is a mixture of about 25 per cent. of sesquioxide of iron, with 75 per cent. of inert material, partly clay, partly sulphate of calcium, partly silica and partly carbonate of lime. With this pigment and this liquid, it will be observed that the proportions in the mixture which is subjected to test for fine grinding are one-half pigment and one-half liquid by weight. (Two grammes of paste are taken, of which 1½ grammes are pigment, and one-half gramme oil. One gramme of oil is added, making 1½ grammes of pigment, and 1½ grammes of liquid.) The standard passenger-car color of the Pennsylvania Railroad Company is a mixture of about 75 per cent. pigment, and 25 per cent. liquid by weight. The liquid is a mixture of about 36 per cent. pure raw linseed oil, and 64 per cent. of spirits of turpentine, also by weight. The pigment contains approximately 80 per cent. sesquioxide of iron, 5 per cent. carbonate of lime, from 5 to 10 per cent. of wood or other lake, and a little inert material. With this

pigment and this liquid, it will be observed that the proportions in the mixture which is submitted to test for fine grinding are about 47 per cent. pigment and 53 per cent. liquid by weight. (Five grammes of paste are taken, of which $3\frac{1}{2}$ grammes are pigment, and $1\frac{1}{2}$ grammes are liquid. Three grammes of oil are added, making $3\frac{1}{2}$ grammes of pigment, and $4\frac{1}{2}$ grammes of liquid.) It would be easy, by varying the proportions of pigment and liquid either way from the figures given, to increase or diminish the severity of the test. A recent attempt to increase the fineness of the grinding of the standard freight-car color, so that the proportions used would be two grammes of paste and two grammes of oil, or about 40 per cent. pigment to 60 per cent. liquid, brought from the manufacturers the statement that to do this would compel them to charge at least 25 per cent. more per pound for the material.

The influence of the nature of the liquid on the test is not difficult to understand. If a paint is ground in japan or varnish, it is clear that the results would be quite different, the test being otherwise the same, than if raw oil or oil and turpentine were used. The more viscous the liquid, or the more the adhesion between pigment and liquid, due to its stickiness, the coarser the grinding may be, and still the material stand the test as above described. Of course by modifying the conditions, such as increasing the proportions of liquid or adding to the paste, turpentine or some other limpid liquid, instead of oil, entirely satisfactory results may be obtained, whatever the nature of the liquid used in grinding the paint. Moreover, direct experiment shows that by adding a single drop of water to material which does not quite stand test, and stirring with the glass rod until the water is uniformly mixed, the material will stand test. The addition of the water apparently converts the oil into an emulsion, which remains with the pigment better than the oil alone. Furthermore, if the oil added to the paste is old, and has become in consequence what the painters call "fatty," shipments will not stand test which are satisfactory when fresh raw oil is used. Apparently the old or fatty oil being changed or different in its nature from fresh oil does not adhere to the pigment as well as the fresher oil. Whatever the explanation, the fact remains.

It seems evident that the nature of the pigment, especially its specific gravity, its mechanical condition, whether compact or flocculent, and especially whether the liquid used wets or adheres to it, or is repelled by it, have an important influence on the test. The exact influence of each of these variables has not yet been worked out.

The influence of the mixing of pigment and liquid on the test may be made quite evident by separating and drying some pigment from a sample of paste which stands test all right, and then mixing some of this pigment with the proper amount of oil, and stirring with a glass rod, and finally submitting some of the material to the test again. It will be found that no amount of stirring, notwithstanding the pigment is so fine that it has once stood test, will ever bring the material into the same condition that it was left by the mill before it was first submitted to test. It seems almost impossible to break up all the aggregations of particles of pigment, and mix them uniformly with oil or liquid by any other means than the mill or its equivalent.

Perhaps the best illustration of the effect of the fineness of the pigment on the test may be obtained by testing any sample of paste for fine grinding, and then passing it through a mill again, testing it again, and so on, taking care to tighten the mill each time before regrinding the paint. It will be found that each grinding, if it is properly managed, makes the material stand a severer test, as shown by the fact that continually more and more oil may be mixed with the paste and still the sample stand test.

It is obvious that this test gives no absolute standard of fine grinding, and that different paints made from different pigments and liquids cannot necessarily be compared with each other by means of it. The query may arise as to when a paint can be said to be ground finely enough. The answer is that this is a question of the uses to which the paint is to be applied, and of money. For freight-car work, or for the outside of buildings, it would probably be poor policy to grind paints as finely as for passenger-car

work, or for the insides of rooms or carriage work or artists' work. On the other hand, there is no doubt but that, for most paints at least, the finer they are ground the more surface they will cover, the more durable they will be, and the more economically and successfully they will be used in the shop, giving at the same time a better job. But, as already stated, the grinding of paint is an expensive process, and, therefore, in each case, how fine the paint shall be ground, must be decided by the conditions.

It may be thought that the stirring with a glass rod to mix the added oil with the paste will have an influence on the test. Experience indicates, however, that the influence of stirring, if any, is so slight that its effect can be ignored.

The direction not to use old or fatty oil has already been commented upon, and the influence of this explained. The effect of water mixed with the paste has also been mentioned. It should also be stated that if a little alkali, caustic or carbonate of soda, or potash, or wood ashes, or caustic lime is added to the paint during grinding, it will stand test with a good deal coarser grinding than if none of these substances are present. In all critical cases it is essential to prove the absence of these materials before being satisfied that the paint is ground sufficiently fine.

Tests may be desired of paints which contain such large proportions of liquid, and such small proportions of pigment, or in which the liquid is so limpid, that however finely the paint may have been ground, the liquid will separate from the pigment when tested. It is obvious that this method does not apply to such paints as these. It is also evident from what has preceded that the same standard of fine grinding does not apply to all paints, but rather that each kind of paint has its own standard, which standard is determined by experience and the conditions of its use.

CONSTRUCTION AND MAINTENANCE OF RAILWAY CAR EQUIPMENT.—VI.

BY OSCAR ANTZ.

(Continued from Page 75.)

DRAFT GEAR—CONTINUED.

There seems to be a tendency with many car builders at the present time to use metal instead of wood in the construction of certain parts of cars, where it can be done to advantage, where, for instance, the parts can be made stronger, lighter, cheaper or less difficult to apply in metal, or where the wood is more than usually subject to decay. No general attempt has yet been made to substitute metal for wood for draft timbers, although in some individual cases of special cars built almost entirely of metal the draft timbers are also of the same material.

A step in this direction has, however, been recently made in the introduction of a device in which "draft arms," made of malleable iron, are substituted for the draft timbers, the drawbar stops and other attachments being made part of the same casting. Figs. 31 and 32 show this arrangement as applied to a car; *A A* are the malleable iron draft arms, which are made in pairs, and each is fastened directly to the sills and face block by four 1-inch bolts, having heads resting in socket castings let into the floor. These draft arms have flanges cast in them at *B B*, against which the followers *C C* rest, forming a front drawbar stop. At the rear end of the draft arms are fastened the back drawbar stops, *D D*, which are held each by one of the bolts through the center sills, and transversely by two bolts passing through both back stops and both draft arms, the back stop acting as distance pieces. Into these back stops are fitted wooden subsills, *E E*, bolted to bottom of center sills and extending, if possible, back to the cross-tie timbers; similar blocks may be fitted between the latter timbers, forming practically a continuous draft timber from end to end of car, to take butting strains. To take pulling strains, flanges are provided on the outside of the draft arms for the reception of the nuts of the draft rods, *F F*, which extend to and through the cross-tie timbers, with nuts on the back of these. Similar rods tie together the cross-tie timbers.

Drawbar guides, *G G*, are provided on the bottom of the draft

arms, the upper guide being formed by the casting itself. The front end of the draft arms is provided with a shoulder, which rests against the projecting portion of the face block, *H H*. Lugs, *I I*, cast on the inside faces of the arms, form guides for the front end of the drawbar. A carry iron, *J J*, of the usual shape is provided under the face block, and just back of it, under the end sill, is

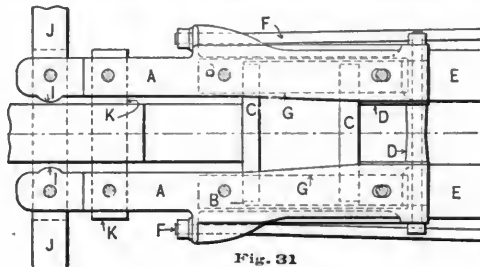


Fig. 31

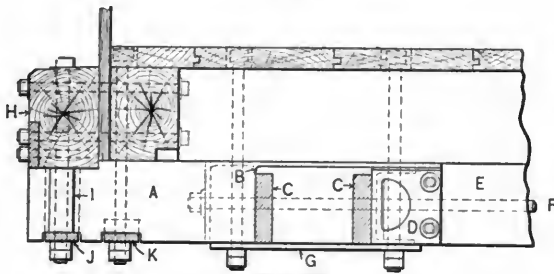


Fig. 32

located an additional tie strap, *K K*, both carry iron and tie strap being let into recesses in the bottom of the arm.

The draft arms shown in the drawings is proportioned for follower plates to take two springs side by side, but of course they can be made for the standard length of follower plate just as well.

DRAWBARS.

The one part of the draft rigging of cars, which has undoubtedly received the most attention, is the coupler or drawbar. The freight couplers in this country, while varying greatly in detail, yet combine in nearly all of them, the general principles of simplicity, ease and rapidity of operation, and in this respect differ so much from many styles in use in other countries, that a passing remark about these will not be out of place. The general idea of most of these foreign couplers is that of a link on one car, passed over a hook on the other and combined often with a more or less elaborately arranged system of screws, levers and springs, by means of which the cars are drawn closely together when coupled; the time and care necessary to couple cars with these contrivances seem entirely out of place to American ideas.

In the early days of railroading this hook and link found its way into American equipment and is still found as the so-called "three link" coupling on some of the four-wheeled coal cars in use on a few of the roads in the Middle States, but is being retired with this class of cars.

The distinctive American coupler of the earlier days is the link-and-pin coupler, in which the drawbars are made with pockets for the reception of a link connecting the two bars, which is secured in each bar by a pin passing through each end of the link and through holes in the bar; this coupler is now considered obsolete and no sketch of it is, therefore, given. Link-and-pin drawbars have been made of cast, wrought and malleable iron, each metal requiring some shape peculiar to itself. Connection to the draft gear was made at first by means of the spindle or tail pin, but was eventually superseded on many roads by the spring pocket or yoke, or some continuous attachment. In coupling cars with the link and pin, the link must be secured in one drawhead and held up and entered into the other drawhead when

skill and is attendant with considerable danger to the switchman, who has to step between the cars to make a coupling. To avoid this danger, a great many devices have been gotten up in connection with this style of drawbar, from a simple rod or stick in the hands of the trainmen, to more elaborate ones combining a mechanism to hold up the link with another to drop the pin, but none of these devices have stood the test of severe service on the road, although some of them seemed to possess at least some good points.

Other inventions were introduced doing away entirely with the link and pin and substituting lugs or similar contrivances projecting from the drawbar which interlocked with each other, and eventually the design, which is now considered a standard in this country was devised. It is the policy of the M. C. B. Association not to recommend any article of a particular manufacture, and no particular coupler is therefore prescribed as a standard. The outlines, however, of the parts in contact when coupled, as well as the sizes and distances of certain other parts are given, which should be followed within certain limits, irrespective of details of the coupling mechanism.

In Figs. 33 and 34 are shown the parts of the coupler which have been adopted as standard. *X X* is the contour line, which is composed of straight lines and arcs of circles, and only the parts in heavy lines are prescribed, the parts of the head back of this being left to the discretion of the designer, as they are not essential to the proper working of the coupler. Variations of $\frac{1}{8}$ and $\frac{1}{4}$ inch at different points are allowed on each side of this contour line, and gages have been devised, giving the limits which must not be exceeded, by means of which couplers and knuckles can be rapidly and accurately tested. The drawbar is 30 inches long from centre line of contact to the end. It is five inches square just back of the head, at *A A*, and has a horn, *B B*, projecting above the head, $8\frac{1}{2}$ inches from centre line of contact; at the rear end are provided rectangular lugs, *C C*, $5\frac{1}{2}$ inches long, 4 inches wide and $6\frac{1}{2}$ inches over the horizontal surfaces, to take a pocket strap. Two $1\frac{1}{8}$ -inch holes are provided, located as shown, for bolting or riveting the strap to the bar by means of $1\frac{1}{2}$ -inch

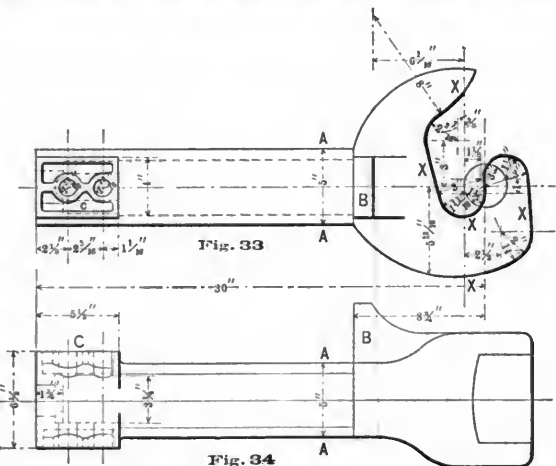


Fig. 34

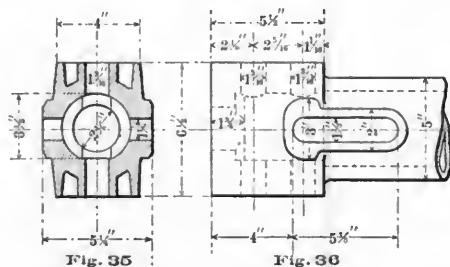


Fig. 35

Fig. 36

the cars come together, and the pin must be dropped at the same time, before the impact separates the cars again. This performance requires more or less bolts or rivets. A hole $2\frac{1}{2}$ inches in diameter and $1\frac{1}{2}$ inches long is provided for a 2-inch tail pin, the drawbar being cored out with a $3\frac{1}{2}$ -inch hole, both the hole and the head of the pin resting in it being flattened on the bottom to keep the pin from turning. When the drawbar is used in connection with the continuous arrangement illustrated in the last article, the rear end shown in Figs. 35 and 36 is used, a horizontal slot for a 1 by 5-inch key being cast in it.

The number of different makes of couplers which conform to the M. C. B. standards is increasing constantly, and it would be out of the question to say that this or that one is the best; naturally the first ones in the market have been adopted by a number of roads, and are being applied to a great extent, but as competition has lowered the price, the newer ones are coming in for some share of the patronage. Elaborate tests have been made and specifications drawn up from time to time, to which drawbars should conform, but as yet no standards for strength or for the dimensions of other points, excepting those mentioned, have been adopted. The question as to the best material for drawbars is still an open one, but malleable iron and steel are at present considered as really the only metals which should be used, and

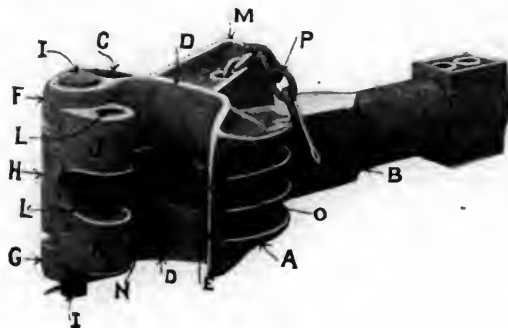


Fig. 37.

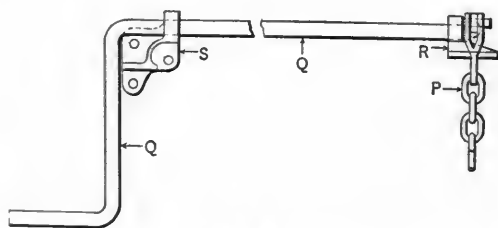


Fig. 38.

each has its numerous friends; the tendency seems to be that drawbars will hereafter be made usually of malleable iron, and the knuckles will be steel castings, which is the practice of many makers at present. The other parts of the coupler are of minor importance and the material in them is generally governed by local conditions in design or manufacture.

Although all the various drawbars differ in the details, they agree in general principles in the more essential parts, and these are shown in Figs. 37 and 38. The drawbar consists of the head, A A, and the shank B B. C C is the side wall of the head, D D the front face, E E the guard arm, M M the horn. Upper and lower lugs, F F and G G are provided, between which the knuckle, H H swings around the knuckle pin, I I. The knuckle has upper and lower lugs, J J and K K, leaving a slot which is used, when necessary to receive a link which is held by a coupling pin in the pin

hole, L L. The knuckle terminates in the tongue, N N, which engages with the lock, O O; the latter is raised and lowered by a chain, P P, attached to the uncoupling shaft, Q Q, fastened to the end sill or end of car by brackets, R R and S S.

The principal difference in the various makes of couplers exists in the knuckle and locking arrangement. Many do not confine themselves to the simple lock, but introduce cams and springs. Knuckles are often arranged to open automatically when the lock is moved, some by means of a spring and some by means of gravity, inclined planes being introduced on the bottom of the knuckle and its bearing point on the head. The lock is usually held in place by gravity alone, and the use of springs for this purpose should be condemned.

Some couplers have been introduced which meet all the requirements of the law, in that they "couple automatically by impact" with each other, but which are not at all like the standard of the M. C. B. Association, and will not couple with this class of coupler without the use of a link and pin. These couplers are no improvement in their most essential part over the old style of drawhead and are mentioned here only as being a good thing to avoid.

In order to be able to couple and uncouple cars without stepping between them the uncoupling rod is extended to the side of the car as shown in Fig. 38. This rod is usually made of 1-inch round iron with an arm bent on it at the centre of the car extending over the coupler to which is attached the chain leading to the lock; the outer end is bent in the form of a crank handle, which when not in use hangs down on the face of end sill or end of car. To release the lock the handle is raised, and if dropped again, the lock will return to its former position; if the knuckle is open and is suddenly thrown back it will raise the lock, which then drops in front of the tongue and holds it in the closed position, until again released. The uncoupling shaft is now usually placed on the left side of the end of the car, the observer standing on the ground facing the end under consideration.

In the switching of cars it is sometimes desirable that the coupler of two adjacent cars be so arranged that they will not couple in case the cars should be moved closely together. This is attained by holding the uncoupling shaft in a position in which it will keep the lock out of action, the usual methods being to provide lugs or slots on one of the brackets in which the shaft works, which will keep the shaft in the desired position if lifted slightly or moved a short distance in the line of its axis.

One of the principal sources of trouble which developed with the introduction of the M. C. B. coupler was that on account of its size it formed quite a serious obstruction if by accident it was pulled out of the car and dropped on the track, and quite a number of wrecks have been caused in this way by the breaking of a tail pin or key. The substitution of the spring pocket for the tail pin on many roads has done away with the primary source of this difficulty, but on cars which still have the spindle other means must be introduced. It has been suggested that the claim of the unlocking device be made of such a length that should the coupler be pulled out an unusual amount it will raise the lock and thereby release the coupler from its adjacent one, preventing its being pulled out completely. An objection is raised to this plan in that the coupler is liable to be released when subjected to a sudden pull, even when there is no defect in the pin.

A device for holding up a coupler after it has been pulled out has been introduced in several modifications, the general principle being the fastening of a Z-shaped casting or forging to each coupler, just over or under the knuckle of the engaging coupler, on which the coupler which is pulled out will hang suspended.

Another means of preventing accidents by trains parting, either by drawbars uncoupling or pulling out, is that of safety chains, and the M. C. B. Association has considered these important enough to recommend a standard practice to be pursued in applying them. Safety chains on freight cars are, however, so little used, that it really seems like adopting the foreign hook-and-link coupling in addition to our own, which in itself should be sufficient, and the subject will not be further touched upon here.

(To be continued.)

(Established 1832.)

AMERICAN ENGINEER CAR BUILDER AND RAILROAD JOURNAL.

27TH YEAR.

65TH YEAR.

PUBLISHED MONTHLY

BY
R. M. VAN ARSDALE,

MORSE BUILDING.....NEW YORK.

M. N. FORNEY,
W. H. MARSHALL, } Editors.

ADVERTISING.

F. H. CLARKE, Morse Building, New York.

R. G. CHASE, 703 Western Union Building, Chicago.

JUNE, 1896.

Subscription.—\$2.00 a year for the United States and Canada; \$2.50 a year to Foreign Countries embraced in the Universal Postal Union.

EDITORIAL ANNOUNCEMENTS.

Advertisements.—Nothing will be inserted in this journal for pay, EXCEPT IN THE ADVERTISING PAGES. The reading pages will contain only such matter as we consider of interest to our readers.

Special Notice.—As the AMERICAN ENGINEER, CAR BUILDER AND RAILROAD JOURNAL is printed and ready for mailing on the last day of the month, correspondence, advertisements, etc., intended for insertion must be received not later than the 25th day of each month.

Contributions.—Articles relating to railway rolling stock construction and management and kindred topics, by those who are practically acquainted with these subjects, are specially desired. Also early notices of official changes, and additions of new equipment for the road or the shop, by purchase or construction.

To Subscribers.—The AMERICAN ENGINEER, CAR BUILDER AND RAILROAD JOURNAL is mailed regularly to every subscriber each month. Any subscriber who fails to receive his paper ought at once to notify the postmaster at the office of delivery, and in case the paper is not then obtained this office should be notified, so that the missing paper may be supplied. When a subscriber changes his address he ought to notify this office at once, so that the paper may be sent to the proper destination.

The paper may be obtained and subscriptions for it sent to the following agencies: **Chicago,** Post Office News Co., 217 Dearborn Street. **London, Eng.,** Sampson Low, Marston & Co., Limited, St. Dunstan's House, Fetter Lane, E. C.

CONTENTS.

ILLUSTRATED ARTICLES:	Page.	MISCELLANEOUS:	Page.
Altoona Shop of the Penna. Rr.	89	New York Central Engine No. 923	94
Malleable Iron Piston, N. & W. Pennsylvania Ave. Subway and Tunnel in City of Philadelphia.	95	Admission of Apprentices and Mechanics to Purdue.	91
Graphical Methods of Keeping Accounts.	101	Should a Railroad Adopt Electric Motive Power to Meet the Competition of Electric Lines?	98
Construction and Maintenance of Railway Car Equipment.	103	Contributions to Practical Railroad Information.	101
Effect upon Diagrams of Long Pipe Connections to Indicators	112	Notes.	110
Multiple Tool Holder for Turning and Cutting off Packing.	115	Beecham & Post's System of Water-Spray Firing.	114
Cast Iron Smoke Stack, C. & N. W. Ry.	116	Quadruple Expansion Engine.	115
A Substantial Indicator Rigging for Locomotives.	118	Comparative Cost of Pitsch and City Gas for Car Lighting.	116
		A New Water-Tight Bulkhead Door for Steamships.	119
		Successful Trial of Professor Langley's Aerodrome.	120
		Personals.	120
		Col. Frank K. Hain.	121
		Equipment Notes.	122
		Trade Catalogues.	123
		Jungfrau Railway.	123
		Steam Boiler Plant of the National Electrical Exposition.	124
		Cast-Iron Wheels for Europe.	124
		Hushnell Car Seats.	125
		Manufacturing Paragraphs.	125
		Our Directory.	126
EDITORIALS:			
Our New Form.	106		
Electricity on Steam Roads.	106		
Effect of Pipe Connections on Indicator Diagrams.	106		
Pumps vs. Compressors for Shop Use.	106		
Car Wheels.	107		
The Value of a Patent.	109		
Tobacco Once More.	109		

OUR NEW FORM.

At the time that the *American Engineer and Railroad Journal* was consolidated with the *National Car and Locomotive Builder*, owing to existing contracts for advertising, it was impossible to adopt the preferable size and form of the first named paper for the new publication. Since then negotiations with advertisers have made it practicable to change the size of page and general make-up of the paper to that which is presented to our readers in this number. It is hoped that it will commend itself to them, and it is the intention of its owners and editors in making the change to improve not only its form, but also the matter which it will contain, and it will be their aim to make its contents more interesting and valuable hereafter than they have ever been during any portion of the past sixty-four years of its existence.

The problem of the application of electricity to steam roads, as it now confronts managers of the latter interests, is neatly stated by the Massachusetts Railroad Commission, and will repay a careful reading. The question is one of economy. The mechanical and electrical questions have already been solved or are capable of solution without going too far into the field of the experimental. If a road can employ electricity in certain localities and thereby serve the public better, without loss to itself, it most certainly is justified in making the change, but if it adopts electricity in the hope of crushing the competition of suburban or inter-urban street-car lines and wresting from them a traffic which is naturally theirs, even if it has heretofore been conducted by the steam road, the move is one of doubtful wisdom. The steam roads need not fear outside competition for long-distance traffic, and if electricity ultimately becomes more economical than steam for the transportation of heavy trains over long distances, it will be adopted without the pressure of competition.

The paper on the effect of long pipe connections on indicator diagrams, published elsewhere in this issue, is worthy of more than passing notice. In it Professor Goss shows conclusively that the effect upon the area of the card is much greater than is usually supposed, and that for all ordinary work it causes the card to show a greater mean effective pressure than actually exists in the cylinder. It is probable that most of the indicator work in marine and stationary engine practice has not contained appreciable errors, because the connections have usually been quite short, but in locomotive practice few cards have been taken where the pipes were less than about three feet in length. Such cards may, therefore, be considered as too inaccurate to serve as the basis of very important deductions, though they may suffice for ordinary work. It would appear that what is now wanted is an indicator rig that can be applied to locomotives in which the pipe connections will be short enough to practically eliminate these errors. This is not easy, for large modern locomotives have so little clearance over the cylinder casings that a rig occupying any great space outside of the steam chest casings is in danger of being stripped off while the engine is running, and such a location of the indicator adds greatly to the danger to the operator. It is interesting to note that if the areas of cards taken at high speed are ten or more per cent. in excess of the actual mean effective pressure in the cylinders, train resistances, which already appear to be surprisingly low under such conditions, must be scaled down still further, thus making commonly accepted rules appear more inaccurate than ever.

PUMPS VS. COMPRESSORS FOR SHOP USE.

We had thought that everybody was convinced of the fact that air for shop use cannot be economically compressed in air-brake pumps, but if the May meeting of the Central Railroad Club is correctly reported in the Buffalo papers (and these reports are usually official), a committee submitted a report on air-brake testing plants in which they advocated the use of

pumps instead of compressors on the score of economy, and in the discussion that followed, Mr. Higgins, of the Lehigh Valley, and Mr. McKenzie, of the Nickel Plate, were the only dissenting parties. Unfortunately for the committee, if their opinions are correctly quoted, it can easily be proven that it is economy to replace even a single pump with a compressor, and, in testing plants adjacent to shops where air can be used for other purposes also, thus requiring the capacity of several pumps, their use instead of compressors is extremely wasteful.

Comparisons between large steam-air compressors and pumps have been made in the past, but we are not aware that any attempt has been made to show the relative economy of pumps and small steam or belt compressors. For that reason it may be well to enquire into the matter. Two years ago the writer made some tests of 8-inch brake pumps in which it was found that for every pound of steam passing through the pumps there was on the average about 2.25 cubic feet of free air compressed to 70 pounds pressure. For every 1,000 cubic feet of air compressed there is therefore required 445 pounds of water, and if the evaporation of the boiler supplying the steam is taken at 8, the coal required is 55.6 pounds. The capacity of one 8-inch pump with 80 pounds of steam is about 1,000 cubic feet per hour, and if we assumed that the pump ran the equivalent of 10 hours per day for 300 days in a year the annual coal consumption is $55.6 \times 10 \times 300$, or 83 tons. As it is seldom that a single pump is of sufficient capacity for a yard or shop and as even the smallest belt compressors are usually of the capacity of two such pumps, we will first make a comparison on the basis of 2,000 cubic feet of free air compressed per hour, requiring two pumps consuming 166 tons of coal per year. It might here be remarked that as the speed of pumps vary considerably with slight differences of pressure, it may reasonably be urged that one pump might be made to do this work if higher steam-pressure were used; but if this is done the coal consumption is not altered materially, nearly the same amount of steam passing through one pump instead of two.

In considering compressors of small capacity those driven by belts must not be overlooked. We find by investigation that in this type about 2.8 horse power is required at the belt for each 1,000 cubic feet of air compressed per hour. If the shop engine consumes $3\frac{1}{2}$ pounds of coal per horse power per hour and the loss in transmission by shafting, belts, etc., is 40 per cent., the coal per horse power at the compressor becomes $3.5 \div .6 = 5.8$ pounds, and for compressing 2,000 cubic feet of air it is $2.8 \times 2 \times 5.8 = 32.4$ pounds. For a year of the same number of hours as before, the consumption is $32.4 \times 10 \times 300 = 48\frac{1}{2}$ tons.

In a steam compressor the horse-power per 1,000 cubic feet of air compressed, including the internal friction of the engine, we will take as 3.2, though it will vary somewhat with the construction of the compressor. In one having only 2,000 cubic feet capacity per hour a horse power cannot be expected on less than $4\frac{1}{2}$ pounds of coal with the evaporation we have assumed, and it might easily be more. Taking it at that figure the annual consumption would be $3.2 \times 2 \times 4.5 \times 10 \times 300 = 43$ tons.

Now a belt compressor of 2,000 cubic feet capacity per hour and provided with an automatic regulator or governor can be bought for from \$300 to \$250, and a steam compressor of that capacity will cost in the neighborhood of \$350. Two brake pumps, even if they are not new, will represent an investment of from \$100 to \$200 according to their age. The comparison between the two types of compressors and the pumps might be summarized in tabular form thus:

	Value of investment.	Coal consumed in tons per annum.	Cost of fuel per annum at \$1 per ton.	Saving per annum.	Saving capitalized at 6 per cent.
Two second-hand pumps.	\$100	166 tons.	\$166.50	.....	.....
One belt compressor	225	48 $\frac{1}{2}$ "	48.50	.....	\$1,058
One steam compressor	350	43 "	43	\$117	2,050

From the columns showing the annual saving and the same capitalized at 6 per cent., it will be seen that if the air-brake pumps were to be had for nothing it would still pay to buy the

compressors if they cost less than \$2,000. Perhaps a more striking way to view it is that if a road were offered two pumps and a bonus of \$1,500 with them, their use to be confined to pumping air for shop use, it would be wise to refuse the offer and to purchase a compressor at market prices. If only one pump were needed it would still pay to buy a compressor of the size mentioned above, and the saving per year in fuel would still be more than \$50.

We think the above figures are fair and not in the least exaggerated. If any one is disposed to quibble over some of the items, let him consider what the comparison would become according to his own figures if coal were at the same time taken at, say, \$2.00 per ton, a price which many pay for it.

The figures seem to prove conclusively that though the air-brake pump is admirably adapted for the service which it was designed and is almost beyond criticism when on an engine, it is in the wrong place when compressing air for shop uses. If managers, purchasing agents, and others who wield the blue pencils that occasionally disfigure requisitions, could be made to realize these facts there would be more compressors purchased, for many officials in the mechanical departments who know the wastefulness of pumps cannot induce their managements to purchase compressors.

Before closing we might make a brief comparison between a compressor, with a capacity of about 18,000 cubic feet of free air per hour (a favorite size with some roads) and pumps of the same capacity. On the same basis as the previous comparisons, but assuming that the compressor can furnish a horse power on four pounds of coal, the annual fuel bill for the compressor would be \$346 and of the pumps \$1,500. This is not an ideal case, for we know of one company that had ten air pumps in its shops and now has in their place one large duplex compressor. The latter almost pays for itself in one year, with coal at only \$1 per ton.

CAR WHEELS.

The notes on the Altoona shops, which will be found in another page, contain an account of some thermal tests and failures of cast-iron car wheels under the tests to which they were subjected, which probably add another cause of anxiety to the many which now haunt the minds of railroad men during their waking and probably sometimes their sleeping hours. It will also supply another argument to the makers and vendors of steel-tired wheels in favor of their wares, of which they will, doubtless, not be slow to avail themselves. In view of the experiments referred to, it may be said, interrogatively, that if a cast-iron wheel is cracked in a few seconds by contact with molten cast iron, how long will such wheels stand the application of brakes while descending a grade? It is true that cast-iron wheels are used less and less each year under passenger cars, and the Pennsylvania Railroad is one of the few great lines which still retains them in that branch of their traffic; but the company makes its own wheels, and, as was shown in the tests, those they make were not broken by the application of heat in the manner described. The danger to passenger trains is, however, not eliminated by confining the use of wheels which may be unsafe to freight trains alone. On all double-track roads there is always the possibility of terrible accidents if a wheel is broken under a freight train on a track adjoining another on which passenger trains run.

In view of this danger, it would be interesting to know whether the application of brakes, with the maximum pressure, when the wheels are revolving at their greatest speed, will have the same effect as the contact of melted cast iron had in the tests discovered. If so the inference cannot be escaped that wheels which will not stand such a test are dangerous.

Of course the steel-tired advocates will be prepared to show a ready way out of the difficulty, which will be the substitution of steel-tired wheels for those made of cast iron alone. But there are persons very competent to form an opinion on the subject, who contend that there are as many failures relatively of steel-tired wheels, as there are of those which are properly made of cast iron.

The figures contained in the last annual report of the British Board of Trade covering the year 1895 will have some bearing on this subject. For that year 454 failures of tires are reported in the United Kingdom. Of these it is said:

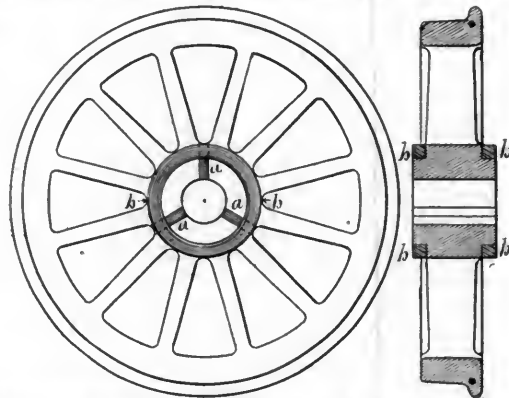
Twenty-one were engine tires, 8 were tender tires, 3 were coach tires, 17 were van tires and 405 were wagon tires: of the wagons, 309 belonged to owners other than railway companies; 268 tires were made of iron and 186 of steel; 12 of the tires were fastened to the wheel by Gibson's patent method; 11 by Mansell's patent method, 3 of which left their wheels when they failed; 3 by Beattie's patent method, 2 of which left their wheels when they failed; 91 by other methods, 50 of which left their wheels when they failed; 43 tires broke at the rivet holes, 1 in the weld, 154 in the solid, and 251 split longitudinally or bulged.

From these data it will be seen that the danger of breakage is not entirely removed by the adoption of steel-tired wheels, even when fastened with retaining rings; neither is it probable that steel-tired wheels will be generally substituted under our freight cars in the immediate future. It seems more likely—and it would appear to be a wise precaution—that railroad companies should specify that the wheels they use or buy should stand some such thermal test as has been described. The test has the advantage that if a wheel stands it it is not made useless thereby. It is not unreasonable, therefore, to expect that some railroad companies may require that several wheels in each 100 they receive shall be subjected to thermal tests, as well as to others which have heretofore been used. That it is possible to make wheels of the ordinary pattern—that is, with two curved plates next the hub and one inside of the rim and joined to the two inner ones, and with curved ribs or brackets in the back—which will stand the test was abundantly shown by the Altoona experiments. But, as is also pointed out in the notes, the experiments show clearly that all wheels are subjected to enormous strains when the rims or treads are heated. Probably the wheels which do not break when so tested are subjected to just as great strains, or at least deformations, as those are which fail, the only difference being that the material in some of them was capable of resisting such strains, whereas that in others was not.

In the design of the kind of wheels which were tested, the plates and the ribs are all made corrugated or curved, under a general impression that such forms will permit a slight amount of movement or deformation without rupture. That such forms are inefficacious in neutralizing the effects of expansion of the rims is indicated by the fracture of the wheels. In other words, those forms do not do what they were intended and were designed for. But is it not possible that some form could be designed which would permit the rims of wheels to be heated and expanded without causing a fracture? It is not easy to understand the nature of the strains which are produced in a wheel by heating its tread, nor how they cause it to fracture, transversely or radially. We have not heard of the experiment being made, but it would not be expected that a cast-iron tire would break transversely if its tread was heated by pouring melted cast iron around it, as was done in the wheel tests. It is proverbially dangerous to prophesy when a prophet is not sure of what will happen, and not having had the opportunity of making such an experiment, all that is asserted here is that we would not expect a cast-iron tire to break under such a test. Apparently what would occur, would be that the expansion would lengthen the ring of metal circumferentially and thus cause it to be enlarged in diameter. Now if we will imagine the inside of the tire to be tied to a central hub by an infinite number of fine radial wires in a state of tension—somewhat as the tire of a bicycle wheel is held—the expansion and consequent enlargement of the tire would apparently have a tendency to rupture the wires or break them by stretching. If the wires were strong enough to resist the tension caused by the expansion of the tire, then it would appear as though it would be subjected to a compressive strain in the direction of its circumference. Now, if instead of the wires we will imagine the tire cast solid on a central plate, as an ordinary wheel is made, then if the rim is heated the plate would be subjected to such radial strains as our hypothetical wires were assumed to resist, and it would again seem as though the rim would be subjected to a circumferential strain of compression.

Or let it be imagined that a tire is fitted accurately to a cast-iron wheel center and is then heated. Obviously the effect will be to enlarge the tire diametrically and circumferentially and make it loose on its center. If it was cemented to the latter, apparently the effect of the expansion would be to break the cement or cause a circumferential fracture, which is what occurs where wheels are subjected to the thermal test described. What is not so plain is why the rim is broken transversely by heating it. If our wires, the cement between the tire or the center, or the plate were elastic, so that they could "give" radially, the strains which tend to break wheels circumferentially when their treads are heated would be relieved. The object of the corrugations in the plates and the curves in the ribs of ordinary wheels is to give this required elasticity. That these do not accomplish their purpose is shown by the tests which are here being commented on. What is needed seems to be greater radial elasticity or mobility in the plate of the wheel.

The generation of railroad men who are now playing the last act of their careers may remember how cast-iron wheels were made forty or fifty years ago. The following sketch, made from



memory, represents the kind which were made in what were considered large numbers by Ross Winans in his foundry in Baltimore.

As shown by the engraving, they were spoke wheels, the spokes being of rectangular section. The three shaded areas, *a, a, a*, in the hub were cored out, so that the hub of the casting was in three parts. Obviously this permitted the different parts of the wheel to expand and contract radially without straining any of them. After the wheel was cast, a steel drift, with a sharp cutting edge, was driven through the slots *a, a, a*, to remove the roughness of the castings. Wrought-iron plates were then driven in, and rings, *p, p*, were shrunk on the hub.

It seems as though a wheel made in that way would not be broken if tested in the manner herein described, which suggests the inquiry whether a form of wheel could not be designed which would have the same freedom to expand and contract that the Winans wheels had, and at the same time be without the obvious objections, which were inherent in that form of construction. It should be said here, that none of the parts of the hub of these wheels, excepting the bore, were machined. The shims *a, a, a*, rings *p, p*, and the bearings were all rough, and it was assumed would fit each other by some process of adaptation, which of course was very improbable. With modern appliances the openings *a, a, a*, could be slotted out, the outside of the hubs and inside of the rings *p, p*, could be turned with but little expense, and thus thoroughly good and reliable work could be done.

In the manufacture of these wheels Winans had considerable difficulty in getting sufficient chill in the throat of the flange, or where it joins the tread. To obviate this difficulty, he placed a wrought-iron ring made of round iron one-half or five-eighths inch diameter, in the mould, as indicated by the blank circles in the section. These rings were first filed bright so that the molten iron would adhere to them, and then anchored in the mould before the casting was made. This method of manufacture was employed for some years, but was finally abandoned, we believe

for the reason that the castings could not be made entirely sound in the vicinity of the rings.

Of course we are aware that numberless experiments have been made on cast-iron wheels, and that the number of forms which have been designed, proposed and patented is legion. Still improvement does not seem to be hopeless in this direction, as it is certain that the forms of wheel centers now used will not permit the parts to expand and contract without subjecting some of them to enormous strains.

At the Pittsburgh meeting of the American Institute of Mining Engineers, Mr. A. E. Outerbridge, Jr., of Philadelphia, read a very interesting paper with the title "The Mobility of Molecules on Cast Iron." In it he showed—on what seems to be conclusive proof—that under the influence of repeated shocks cast iron, instead of becoming brittle, as is ordinarily supposed, and weakened, has exactly the opposite effect produced by such treatment, and as a result of almost a thousand tests of bars of cast-iron of all grades, it was proved that it is materially strengthened by subjection to repeated shocks and blows. In view of the remarkable revelation which Mr. Outerbridge has made, it would be interesting to know whether cast-iron wheels which had been in service for a considerable time will stand the thermal test and other tests any better than new wheels do. It may be that eventually we will be obliged to subject such wheels to a sort of Swedish movement cure, or process of dynamic annealing, by subjecting them to a great number of repeated shocks in order to increase their strength. Those of an inventive turn of mind will readily conceive of a machine having a number of hammers acting radially, or in an axial direction to a wheel which would then be slowly revolved while it was subjected to an infinite or a great number of blows, to give the particles of the metal "mobility" and thus strengthen it and increase its capacity to resist thermal and other strains. In the language of patent specifications, "having thus fully described our invention, what we claim"—the reader can fill in.

THE VALUE OF A PATENT.

Our "esteemed contemporary," *Locomotive Engineering*, in its May issue, makes the following observations: "A patent has been obtained by Mr. M. N. Forney on a combination . . . of piston valve and cut-off, operated by a radial motion, which has a very close relationship to Joy's motion. We wish Mr. Forney much good luck out of his invention, but if he proposes to give a stock company the opportunity to boom the latest thing in valve-gear we must respectfully intimate that all our money is tied up."

That parties engaged in publishing two papers, one monthly and the other weekly should have "all their money tied up," is not a new phenomenon. In placing the stock of the new company, which our cotemporary intimates is about to be organized, none of it will therefore be assigned to the proprietors of the two papers, as other manufacturing enterprises seem to have absorbed all their spare cash, and they will thus lose the opportunity of "coming in on the ground floor." It has not yet been decided upon what basis the new patent will be capitalized, but due announcement will be made thereof. In the meanwhile we hope our cotemporary will not bear the market by detracting from the merits of the invention, and thus wrecking the company, which has not yet been formed. At present it is impossible to say "what there is in it for them," but if their silence cannot be secured in any other way, and as the senior editor of our cotemporary has had much secretarial experience, that position—without any salary—might be assigned to him as soon as a million of dollars of the stock is disposed of at par.

It is a curious fact that people without wit are apt to think that jokes are vulgar, and it is also true that men without ingenuity can seldom appreciate the value of a new and untried invention, which reminds us of a little story: Down in Pennsylvania a Dutch farmer had a dog which disturbed one of his neighbor's sheep. The neighbor shot the dog; whereupon suit was brought before a country "squire" by the owner to recover damages. When the case came up for a hearing the squire inquired—no pun intended

—of the owner, with reference to the value of the dog. "Oh," the man replied, "he wasn't worth a dam. All I want is to make this man Fritz pay for him." Now it may be that the patent herein referred to is like the Dutchman's dog, and not worth a dam; but it is our infant, and we feel bound to defend it from such aspersions as our cotemporary has gently poured over it.

In the meanwhile, applicants for stock in the new company may address the Consulting Engineer of this paper.

TOLERANCE OF TOBACCO.

In the April issue of this paper we published an article which, to some extent, was an arraignment of the demerits of tobacco or the tobacco habit. Our "esteemed cotemporary," the *Railway Master Mechanic*, in an article on the same subject in the May number of that publication, dissents from the views which were advanced by us and which were then supported by much venerable authority. To the evil effects which were imputed to tobacco in our article, it seems, from our cotemporary's response, one more must be added, that of logical distortion, and it illustrates the truth of the Eastern proverb, that "reason is captive in the arms of the appetites as a weak man in the hands of an artful woman."

The writer referred to says the principal count in the indictment is that "tobacco is disagreeable to those who do not use it." In support of this, much testimony from wise, venerable and honored authorities was quoted. This our cotemporary discredits because the old worthies spelled execrably. Judged by this standard all wisdom which is more than a hundred years old must be discarded.

Our critic says that tobacco has the odor which the Lord gave it, and so has the onion, and therefore draws the inference that it is our duty to like both. The same observation will apply to the skunk. Our respondent says further that when persons are not endowed with a liking for such delectable perfumes that "the Lord makes up for the want by giving them other and special gifts and graces." Because woman don't like the smell of onions and tobacco she has been made good-looking. We are at present at a loss to know what is the special "gift" or "grace" with which our esteemed critic was endowed as a compensation for not enjoying the aroma of a pole-cat, whose perfume was nature's gift. It may be a source of satisfaction to beautiful women to know that they have been made so because they do not enjoy bad smells, but we would not advise our commentator to suggest to any of them such a reason for being good-looking, nor would it be judicious to solace any of the plain sisters by congratulations on their enjoyment of fetid odors.

He excuses the "universal and mighty craving" for tobacco by the fact that one "beautiful yearling deer, a few horses and some goats hanker after it." He adds further that the reason more beasts do not acquire the habit is that they have not the opportunity. In man only, he says, "the mighty instinct prevails." He should have spelled it *instinkt*, and then by inversion his argument concisely stated would be that the *instinkt* of smokers is stronger than that of beasts, which some of us are inclined to believe, but have not had the courage to state in its bald simplicity.

With reference to the Hottentot method of killing snakes by putting a drop of oil on their tongues, which our Chicago critic discredits, something should, perhaps, be said. Whether he suffers from snakes or not, we are not informed, but his familiarity with the methods of killing them is suggestive. We can assure him, however, that killing serpents by putting oil of tobacco on their tongues bears the same relation to the destruction of reptiles that the traditional salt deposited on their tails has to the catching of birds. We can assure him that if he is troubled with snakes, if he will only "catch them by the neck, force their jaws open and carefully deposit one drop of oil of tobacco on their tongues" and then live a sober and virtuous life, he will not be troubled with such varmints thereafter.

Our cotemporary sums up our argument by saying that we assume the attitude to others that "their tobacco is disagreeable to us, and, therefore, they ought not to use it." If he will modify this statement by the assertion that "when the use of tobacco is

The figures contained in the last annual report of the British Board of Trade covering the year 1895 will have some bearing on this subject. For that year 454 failures of tires are reported in the United Kingdom. Of these it is said:

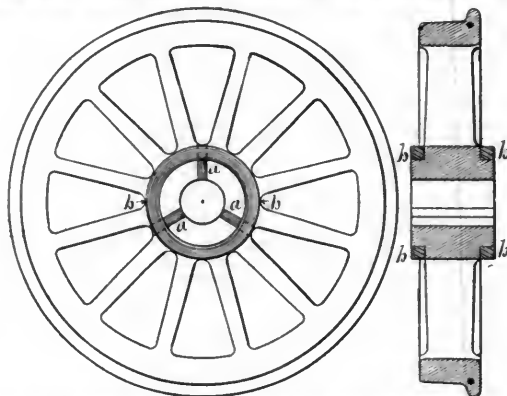
Twenty-one were engine tires, 8 were tender tires, 3 were coach tires, 17 were van tires and 405 were wagon tires; of the wagons, 309 belonged to owners other than railway companies; 268 tires were made of iron and 186 of steel; 12 of the tires were fastened to the wheel by Gibbon's patent method; 11 by Mansell's patent method, 3 of which left their wheels when they failed; 3 by Beattie's patent method, 2 of which left their wheels when they failed; 91 by other methods, 50 of which left their wheels when they failed; 48 tires broke at the rivet holes, 11 in the weld, 154 in the solid, and 251 split longitudinally or bulged.

From these data it will be seen that the danger of breakage is not entirely removed by the adoption of steel-tired wheels, even when fastened with retaining rings; neither is it probable that steel-tired wheels will be generally substituted under our freight cars in the immediate future. It seems more likely—and it would appear to be a wise precaution—that railroad companies should specify that the wheels they use or buy should stand some such thermal test as has been described. The test has the advantage that if a wheel stands it it is not made useless thereby. It is not unreasonable, therefore, to expect that some railroad companies may require that several wheels in each 100 they receive shall be subjected to thermal tests, as well as to others which have heretofore been used. That it is possible to make wheels of the ordinary pattern—that is, with two curved plates next the hub and one inside of the rim and joined to the two inner ones, and with curved ribs or brackets in the back—which will stand the test was abundantly shown by the Altoona experiments. But, as is also pointed out in the notes, the experiments show clearly that all wheels are subjected to enormous strains when the rims or treads are heated. Probably the wheels which do not break when so tested are subjected to just as great strains, or at least deformations, as those are which fail, the only difference being that the material in some of them was capable of resisting such strains, whereas that in others was not.

In the design of the kind of wheels which were tested, the plates and the ribs are all made corrugated or curved, under a general impression that such forms will permit a slight amount of movement or deformation without rupture. That such forms are inefficacious in neutralizing the effects of expansion of the rims is indicated by the fracture of the wheels. In other words, those forms do not do what they were intended and were designed for. But is it not possible that some form could be designed which would permit the rims of wheels to be heated and expanded without causing a fracture? It is not easy to understand the nature of the strains which are produced in a wheel by heating its tread, nor how they cause it to fracture, transversely or radially. We have not heard of the experiment being made, but it would not be expected that a cast-iron tire would break transversely if its tread was heated by pouring melted cast iron around it, as was done in the wheel tests. It is proverbially dangerous to prophesy when a prophet is not sure of what will happen, and not having had the opportunity of making such an experiment, all that is asserted here is that we would not expect a cast-iron tire to break under such a test. Apparently what would occur, would be that the expansion would lengthen the ring of metal circumferentially and thus cause it to be enlarged in diameter. Now if we will imagine the inside of the tire to be tied to a central hub by an infinite number of fine radial wires in a state of tension—somewhat as the tire of a bicycle wheel is held—the expansion and consequent enlargement of the tire would apparently have a tendency to rupture the wires or break them by stretching. If the wires were strong enough to resist the tension caused by the expansion of the tire, then it would appear as though it would be subjected to a compressive strain in the direction of its circumference. Now, if instead of the wires we will imagine the tire cast solid on a central plate, as an ordinary wheel is made, then if the rim is heated the plate would be subjected to such radial strains as our hypothetical wires were assumed to resist, and it would again seem as though the rim would be subjected to a circumferential strain of compression.

Or let it be imagined that a tire is fitted accurately to a cast-iron wheel center and is then heated. Obviously the effect will be to enlarge the tire diametrically and circumferentially and make it loose on its center. If it was cemented to the latter, apparently the effect of the expansion would be to break the cement or cause a circumferential fracture, which is what occurs where wheels are subjected to the thermal test described. What is not so plain is why the rim is broken transversely by heating it. If our wires, the cement between the tire or the center, or the plate were elastic, so that they could "give" radially, the strains which tend to break wheels circumferentially when their treads are heated would be relieved. The object of the corrugations in the plates and the curves in the ribs of ordinary wheels is to give this required elasticity. That these do not accomplish their purpose is shown by the tests which are here being commented on. What is needed seems to be greater radial elasticity or mobility in the plate of the wheel.

The generation of railroad men who are now playing the last act of their careers may remember how cast-iron wheels were made forty or fifty years ago. The following sketch, made from



memory, represents the kind which were made in what were considered large numbers by Ross Winans in his foundry in Baltimore.

As shown by the engraving, they were spoke wheels, the spokes being of rectangular section. The three shaded areas, *a, a, a*, in the hub were cored out, so that the hub of the casting was in three parts. Obviously this permitted the different parts of the wheel to expand and contract radially without straining any of them. After the wheel was cast, a steel drift, with a sharp cutting edge, was driven through the slots *a, a, a*, to remove the roughness of the castings. Wrought-iron plates were then driven in, and rings, *p, p*, were shrunk on the hub.

It seems as though a wheel made in that way would not be broken if tested in the manner herein described, which suggests the inquiry whether a form of wheel could not be designed which would have the same freedom to expand and contract that the Winans wheels had, and at the same time be without the obvious objections, which were inherent in that form of construction. It should be said here, that none of the parts of the hub of these wheels, excepting the bore, were machined. The slims *a, a, a*, rings *p, p*, and the bearings were all rough, and it was assumed would fit each other by some process of adaptation, which of course was very improbable. With modern appliances the openings *a, a, a*, could be slotted out, the outside of the hubs and inside of the rings *p, p*, could be turned with but little expense, and thus thoroughly good and reliable work could be done.

In the manufacture of these wheels Winans had considerable difficulty in getting sufficient chill in the throat of the flange, or where it joins the tread. To obviate this difficulty, he placed a wrought-iron ring made of round iron one-half or five-eighth inch diameter, in the mould, as indicated by the blank circles in the section. These rings were first filed bright so that the molten iron would adhere to them, and then anchored in the mould before the casting was made. This method of manufacture was employed for some years, but was finally abandoned, we believe

for the reason that the castings could not be made entirely sound in the vicinity of the rings.

Of course we are aware that numberless experiments have been made on cast-iron wheels, and that the number of forms which have been designed, proposed and patented is legion. Still improvement does not seem to be hopeless in this direction, as it is certain that the forms of wheel centers now used will not permit the parts to expand and contract without subjecting some of them to enormous strains.

At the Pittsburgh meeting of the American Institute of Mining Engineers, Mr. A. E. Outerbridge, Jr., of Philadelphia, read a very interesting paper with the title "The Mobility of Molecules on Cast Iron." In it he showed—on what seems to be conclusive proof—that under the influence of repeated shocks cast iron, instead of becoming brittle, as is ordinarily supposed, and weakened, has exactly the opposite effect produced by such treatment, and as a result of almost a thousand tests of bars of cast-iron of all grades, it was proved that it is materially strengthened by subjection to repeated shocks and blows. In view of the remarkable revelation which Mr. Outerbridge has made, it would be interesting to know whether cast-iron wheels which had been in service for a considerable time will stand the thermal test and other tests any better than new wheels do. It may be that eventually we will be obliged to subject such wheels to a sort of Swedish movement cure, or process of dynamic annealing, by subjecting them to a great number of repeated shocks in order to increase their strength. Those of an inventive turn of mind will readily conceive of a machine having a number of hammers acting radially, or in an axial direction to a wheel which would then be slowly revolved while it was subjected to an infinite or a great number of blows, to give the particles of the metal "mobility" and thus strengthen it and increase its capacity to resist thermal and other strains. In the language of patent specifications, "having thus fully described our invention, what we claim"—the reader can fill in.

THE VALUE OF A PATENT.

Our "esteemed contemporary," *Locomotive Engineering*, in its May issue, makes the following observations: "A patent has been obtained by Mr. M. N. Forney on a combination . . . of piston valve and cut-off, operated by a radial motion, which has a very close relationship to Joy's motion. We wish Mr. Forney much good luck out of his invention, but if he proposes to give a stock company the opportunity to boom the latest thing in valve-gear we must respectfully intimate that all our money is tied up."

That parties engaged in publishing two papers, one monthly and the other weekly should have "all their money tied up," is not a new phenomenon. In placing the stock of the new company, which our cotemporary intimates is about to be organized, none of it will therefore be assigned to the proprietors of the two papers, as other manufacturing enterprises seem to have absorbed all their spare cash, and they will thus lose the opportunity of "coming in on the ground floor." It has not yet been decided upon what basis the new patent will be capitalized, but due announcement will be made thereof. In the meanwhile we hope our cotemporary will not bear the market by detracting from the merits of the invention, and thus wrecking the company, which has not yet been formed. At present it is impossible to say "what there is in it for them," but if their silence cannot be secured in any other way, and as the senior editor of our cotemporary has had much secretarial experience, that position—without any salary—might be assigned to him as soon as a million of dollars of the stock is disposed of at par.

It is a curious fact that people without wit are apt to think that jokes are vulgar, and it is also true that men without ingenuity can seldom appreciate the value of a new and untried invention, which reminds us of a little story: Down in Pennsylvania a Dutch farmer had a dog which disturbed one of his neighbor's sheep. The neighbor shot the dog; whereupon suit was brought before a country "squire" by the owner to recover damages. When the case came up for a hearing the squire inquired—no pun intended

—of the owner, with reference to the value of the dog. "Oh," the man replied, "he wasn't worth a dam. All I want is to make this man Fritz pay for him." Now it may be that the patent herein referred to is like the Dutchman's dog, and not worth a dam; but it is our infant, and we feel bound to defend it from such aspersions as our cotemporary has gently poured over it.

In the meanwhile, applicants for stock in the new company may address the Consulting Engineer of this paper.

TOLERANCE OF TOBACCO.

In the April issue of this paper we published an article which, to some extent, was an arraignment of the demerits of tobacco or the tobacco habit. Our "esteemed cotemporary," the *Railway Master Mechanic*, in an article on the same subject in the May number of that publication, dissents from the views which were advanced by us and which were then supported by much venerable authority. To the evil effects which were imputed to tobacco in our article, it seems, from our cotemporary's response, one more must be added, that of logical distortion, and it illustrates the truth of the Eastern proverb, that "reason is captive in the arms of the appetites as a weak man in the hands of an artful woman."

The writer referred to says the principal count in the indictment is that "tobacco is disagreeable to those who do not use it." In support of this, much testimony from wise, venerable and honored authorities was quoted. This our cotemporary discredits because the old worthies spelled execrably. Judged by this standard all wisdom which is more than a hundred years old must be discarded.

Our critic says that tobacco has the odor which the Lord gave it, and so has the onion, and therefore draws the inference that it is our duty to like both. The same observation will apply to the skunk. Our respondent says further that when persons are not endowed with a liking for such delectable perfumes that "the Lord makes up for the want by giving them other and special gifts and graces." Because woman don't like the smell of onions and tobacco she has been made good-looking. We are at present at a loss to know what is the special "gift" or "grace" with which our esteemed critic was endowed as a compensation for not enjoying the aroma of a pole-cat, whose perfume was nature's gift. It may be a source of satisfaction to beautiful women to know that they have been made so because they do not enjoy bad smells, but we would not advise our commentator to suggest to any of them such a reason for being good-looking, nor would it be judicious to solace any of the plain sisters by congratulations on their enjoyment of fetid odors.

He excuses the "universal and mighty craving" for tobacco by the fact that one "beautiful yearling deer, a few horses and some goats hanker after it." He adds further that the reason more beasts do not acquire the habit is that they have not the opportunity. In man only, he says, "the mighty instinct prevails." He should have spelled it *instinkt*, and then by inversion his argument concisely stated would be that the *instinkt* of smokers is stronger than that of beasts, which some of us are inclined to believe, but have not had the courage to state in its bald simplicity.

With reference to the Hottentot method of killing snakes by putting a drop of oil on their tongues, which our Chicago critic discredits, something should, perhaps, be said. Whether he suffers from snakes or not, we are not informed, but his familiarity with the methods of killing them is suggestive. We can assure him, however, that killing serpents by putting oil of tobacco on their tongues bears the same relation to the destruction of reptiles that the traditional salt deposited on their tails has to the catching of birds. We can assure him that if he is troubled with snakes, if he will only "catch them by the neck, force their jaws open and carefully deposit one drop of oil of tobacco on their tongues" and then live a sober and virtuous life, he will not be troubled with such varmints thereafter.

Our cotemporary sums up our argument by saying that we assume the attitude to others that "their tobacco is disagreeable to us, and, therefore, they ought not to use it." If he will modify this statement by the assertion that "when the use of tobacco is

offensive to others no gentleman will indulge in the habit," we will accept the statement as being all that can reasonably be contended for.

NOTES.

On the Lake Shore & Michigan Southern Railroad much attention has been given for some time past to the proper loading of freight cars and freight trains. At large terminals, particularly Buffalo, extensive transfers of freight have been made, and cars partially loaded received from other roads have not been hauled in that condition if it is possible to avoid it. The same care has been exercised in the loading of engines, and the result of all this work and the co-operation of the various departments interested has been a gratifying increase in the average carload and in the average trainload. In the annual report of the company for 1895 it is stated that while the ton mileage for that year was the largest in the history of the company, being 12.73 per cent. greater in 1894, the freight train mileage was decreased 5.42 per cent. (from 8,218,912 miles in 1894 to 7,773,337 miles in 1895), and this in connection with an increase in the average freight-train load from 267.2 tons in 1894 to 318.5 tons in 1895, is one of the chief causes of the gratifying results in the net earnings as shown in the 1895 report.

A form of built-up crank axle has been adopted for some classes of locomotives by Mr. F. W. Webb, Chief Mechanical Engineer of the London & Northwestern Railway of England. The object is to get more effective crank pin surface for the main rods, this surface being ordinarily considerably narrowed by the radii at each end. In the built-up shaft the crank pins and driving-box journals are cas hardened. The section of the axle between the cranks has the four eccentrics forged on it.

The Committee on subjects for the 1897 Convention of the Master Car Builders' Association are desirous that members send to the Chairman a list of one or more subjects, which will, in their opinion, be desirable for committee work during the coming year. The Committee also ask for suggestions of subjects for topical discussions for the noon hours during the 1896 convention. Replies are to be sent to A. M. Waitt, General Master Car Builder, Lake Shore & Michigan Southern Railway, Cleveland, O., not later than June 1, 1896, but we would suggest that members who have not complied with the Committee's request can write now or seek out the members at convention, and their suggestions, though late, will be welcome.

Electric drills have ceased to be a novelty, but certain progressive electrical engineers are not content with what has been accomplished in this inviting field. The ordinary brace and ratchet drill is relegated to the small shop. In English shipyards, says *Engineering Mechanics*, the electric motor is suspended by a rope and pulley, which has a counterweight that admits of movement up and down by the workmen. By easily-controlled mechanism the motor is steadied, and the drill can be worked 200 to 300 revolutions, but 70 to 100 is the average. The most ingenious device for driving drilling tools bores a series of holes one after another. In the electric drilling motor, as developed in some yards, each of its three legs is now an independent magnet, having a positive and negative pole. The face of each leg has three concentric spaces. The inner circle composes the negative pole, the outer ring the positive pole, a concentric portion between the two being filled with insulating material. Thus a perfectly steady tripod is afforded, and there is no danger of the drill breaking by its cutting unevenly through the plate. All these processes are as yet practically in their infancy, but it would seem as though the electric drill had a most important future. The system might be extended, with the aid of the tripod electro-magnetic contact, to slotting and planing, and we have little doubt that this will yet be accomplished. Messrs. Siemens have constructed portable electric motors, running at various speeds from 900 to 1,200 revolutions per minute; these motors being connected up to long flexible cables, associated with a powerful current from a dynamo, and being capable of rapid application to a vertical drill, which

can be worked in any position within the radius provided by the length of the cables, and moved about from spot to spot as required.

As demonstrating the stability of lofty office buildings, the *Scientific American* quotes the results of a test recently carried out on the twenty-first floor of the American Surety Building, Broadway, New York, by the engineer and superintendent of the building, Mr. J. Turner. It was made during the height of a heavy storm which prevailed Jan. 4, when an official wind velocity of 82 miles per hour was registered in the neighboring station. The test failed to give the slightest evidence of vibration; a result which agrees with the testimony of the inmates that in a gale the topmost floors are as still as the first stories. The test was made with transit and level, and though it was not a test of the highest instrumental character, the result was remarkable, for both the plumb bob and the bubble remained perfectly still, even when the building was struck by the heavier gusts of wind.

In 1894 the jury of the section of Mechanical Industries at the Bordeaux Exhibition requested a test of the consumption of a Laval steam turbine of 100 horse power. Arrangements were made to measure the steam fed from a separate boiler, and two tests were carried out, one at the normal power of 98 horse power, the other at half load, 49 horse power. The consumption of steam was, working condensing: At full load, 32.23 pounds per kilowatt, 23.71 pounds per electric horse power, 20.15 pounds per brake horse power; at half load, 40.30 pounds per kilowatt, 29.65 pounds per electric horse power, 23.80 pounds per brake horse power. The efficiency of the dynamo used was taken at 85 per cent. at full and 80 per cent. at half load. A supplementary trial in the workshops of Messrs. Bréguet on a 74-horse power Laval steam turbine for electric lighting was also made. The steam consumption was measured by means of a surface condenser; and in a second trial, with a condenser giving a better vacuum. The object was to show that whatever the vacuum, the consumption, without reference to the work done, remains the same: The first trial lasted three hours. The vacuum was 21.6 inches for the first two hours, and 17.7 during the third; the steam consumption did not vary. In the second trial the vacuum was 25 inches, and the consumption of steam 32.47 pounds per kilowatt. These results prove that the quantity of steam used depends only on the steam pressure and the section of the pipe, and not to the exhaust pressure. If a steam turbine is meant to work economically with a small load, it is necessary to adjust the section of the orifice, and not the pressure of the steam by throttling. This is confirmed by an experiment made on a 10-horse power Laval steam turbine, without condensation, by Mr. Vincotte, Manager of the Belgian Steam Boiler Association. The consumption was 49.2 pounds at 9.7 horse power, and rose to 59.4 pounds at 6.5 horse power, and to 89 pounds at 3.31 horse power; by throttling the admission valve the pressure of the steam was very much reduced on entering the turbine.—*Inst. Civil Engineers—Foreign Abstracts.*

The Lehigh Valley Railroad Company put in service May 18 two trains of elegantly equipped cars for service between New York and Buffalo, which for completeness of detail and for comfort and safety are said to be unexcelled. These trains are to run daily, except Sunday, leaving New York and Buffalo, respectively, about noon, making fast time, and enabling those using the train to devote part of the day to business before the hour of departure, and at the same time offering an opportunity for viewing the scenery for which the Lehigh Valley Railroad is celebrated. The trains consist of a combination baggage, cafe and dining car coaches and an observation and parlor car, one of the features of the latter being a room for ladies, containing lounges, writing tables and easy chairs, with a library of current literature, together with the daily and weekly papers and magazines. Corresponding accommodations for men are found in the combination car, which contains a cafe, library, writing and smoking room. Some time ago General Passenger Agent Chas. S. Lee offered a reward of \$25 in gold to the successful competitor who would suggest a name that should be finally adopted. The name

chosen is the "Black Diamond Express," and C. M. Montgomery, of Toledo, O., gets the \$25.

The steadily increasing business of the Boston & Maine Railroad has necessitated increased shop facilities and a tract of several acres has been purchased just south of the business section of Concord, N. H., where it is the intention to erect shops at once. The plans of the company have not been made public, but it has been surmised that the new shops will be adapted not only for repair work, but also for the construction of cars and locomotives, a line of work not heretofore attempted on this road. The shops at Salem and Lawrence are to be retained.

Some of our readers may be interested in the details of the Sweeney brake, which is designed to utilize the cylinders of the locomotive as air pumps to fill the main reservoir of the brake system when the train is on a heavy grade. The details are few and simple. A 1½-inch pipe is tapped into the steam chest cover and just outside of the casing a 1½-inch plug cock is placed in the pipe. The pipe leads to the main reservoir and the plug cock is operated from the cab by a small rod and lever. Near the plug cock a 1½-inch pop-valve is inserted in the pipe to prevent excessive pressure, and near the main reservoir a 1½-inch non-return check valve is placed in the pipe to prevent air going out of the reservoir through this pipe. This comprises the whole apparatus. It has been reported upon very favorably by those using it in mountainous districts.

On the Union Pacific considerable trouble has been experienced with leaky joints in steam pipes in smokeboxes, and it is believed to be due in part to the thickness of the pipes. With a view of overcoming this trouble, Mr. McConnell has ordered a number of malleable iron pipes, the walls of which will be much thinner. The cast-iron pipes weigh 273 pounds, and the malleable iron ones weigh 148 pounds. The cost of the latter will be about the same as the former, the higher price per pound being offset by the lesser weight.

In a paper read before the Institution of Civil Engineers on the thermal efficiency of steam engines, Capt. H. R. Sankey advocated the comparison of engine performances with a standard thermal efficiency. He proposed as a standard the performance of an ideal engine, whose indicator diagram would be as follows: (1) Admission line at the temperature of the steam at the stop-valve of the engine; (2) expansion line adiabatic, and carried to within 0.15 atmosphere of the back pressure; (3) back pressure: that in the exhaust immediately outside the engine; (4) compression *nil*, and clearance *nil*. The object of limiting the expansion by carrying it down to within 0.15 atmosphere of the actual back pressure, instead of all the way down to the back pressure line, was to avoid encouraging the construction of engines too large for their work; if, on the other hand, the expansion in the standard were only carried to a pressure equal to the back pressure plus the mean pressure, corresponding with the friction of the actual engine, a premium was, so to speak, awarded to the engine with large internal friction, and the standard would be made to vary with the friction of the actual engine. To avoid the lengthy calculation of the absolute thermal efficiency of the proposed standard, curves had been prepared enabling the required result to be obtained by inspection, and numerical examples were given to show the method of application.

The *Engineer* says: A well-known Middlesboro firm of iron merchants has just imported a quantity of pig iron from Alabama. It has, however, been brought over on very exceptional terms, the freight being little more than a merely nominal figure, as the iron was put in as stiffening to a cotton steamer. In the ordinary course the freight would prevent the importation of such iron except at a considerable loss. If the experience of another Middlesboro merchant firm is any criterion, this iron is not likely to be taken up by founders. The firm referred to last year imported some Alabama pig, and it is still on their hands in Liverpool, except a few sample lots. Consumers on this side have not taken kindly to it, as they say it does not suit their purposes.

Though the shops of the Delaware, Lackawanna & Western at Scranton have enough repair work to heavily tax their facilities, Mr. McKenna, the Master Car Builder, has managed to build thus far this year, sixteen new milk cars, two coaches and one mail car. The magnitude of the milk traffic on the road may be judged from the fact that the company has 111 cars devoted to this business. All passenger cars that are overhauled are fitted with vestibules and Gould platforms. If the cars are for through trains the vestibules are provided with side doors, but for local traffic they are omitted. For their through trains between New York and Buffalo the company is putting buffets in four coaches, one for each train, and the urns will be heated with Pintsch gas taken from the reservoirs under the cars. The same use of gas is made on the Wabash and New York, New Haven & Hartford roads.

The Lachine Rapids of the St. Lawrence are about to be utilized. For some time past work has been prosecuted on a large wing dam which runs out for more than 1,000 feet into the St. Lawrence River. A fall of water is secured by means of this dam, sufficient to develop at the low-water season about 15,000 horse-power. This water-power is to be transformed into electricity. Upon the dam a power-house will be built, which will run its entire length and show an unbroken interior of 1,000 feet in length. The basement of this will be occupied by water wheels. The main floor will contain the dynamos, of which there will be 12, each of 1,000 horse-power, or 12,000 horse-power in all. They will generate currents for transmission to Montreal for use there in lighting the city, operating the street railroads, and for any and all other lighting and power purposes.

A correspondent of the *English Mechanic* gives the following direction for oxidizing and blacking the bright work of steel in lieu of paint, to stand heat and to wear well: "Take 3 ounces of glacial acetic acid, mix it with its weight of water, to this add ½ ounce of powdered nut galls, and let stand for a day or two, shaking it up occasionally. Then let settle; then pour off the clear, then put a pint of boiling water to the residue. When cold and settled, pour off the clear and mix with the first. Now to this add a grain of nitrate of silver or sulphate of copper or nitrate of copper. Dissolve whichever you use in a little hot water before mixing with the other liquid. Silver is the best process. Clean all oil off and rust or scabs, paint, etc. Clean all up bright with pumice-stone powder. Don't use emery in any form, but the above with a piece of wood. Then clean all off; dry with air-slaked lime. Now go over it with the liquid with some cotton wool. If you have saved your powdered galls, take a little of that upon your wool, and will find that a great acquisition in the first application. Let stand until dry; then give it another coat. When dry, scrub with brush and give it another coat, etc. When you have got it to your liking, give it some linseed-oil and camphor. All bright iron parts can be made like ebony polished, and with the gun-metal mounting you will have a picture in black and gold. Cylinder covers, etc., can be done the same; but you must wash with hot water before oiling it. It will stand any amount of heat, the hammer and friction in wiping; you have no blistering, and you will have some difficulty in eradicating it. Bicycles, repairs, handle-bars, etc., can be treated the same way to advantage, well washed with hot water; when dry give them a coat of good copal carriage varnish."

A correspondent of the *Scientific American*, writing on raising of the lake levels, says there is much speculation over the utility of dams at the mouth of Lake Ontario and other lakes, but the plan will hardly be tried till something arises to make it appear feasible. It appears that the evidence is now to be had. The first vessel left Buffalo this season on April 20. There was at the time about 80 miles of ice to pass through before reaching open water. This ice disappears mainly through the action of the sun, but during the week, or perhaps fortnight, taken for it to disappear, large masses of it become detached and pass down the river. Naturally, this ice occasionally strikes the rocks at the head of the river, as the water is shallow, where it forms an imperfect dam. For some time the vessel men in the harbor noticed that the depth of water was subject to sudden variations.

An observation of the water line on the docks would show a rise or a fall of a foot or more in an hour or so. These changes were carefully observed now for the first time, as there was so much more dependent on the depth of water than usual at this time of year. The water level is materially affected by the wind, but there were changes of level that took place with no corresponding change of the wind, and it was at length found that whenever the ice field escaping into the river was caught on the shoal at the head of it the water rapidly rose and the vessels aground inside the harbor could be released. The main point of the showing seems to be the effectiveness of so frail and irregular a barrier as that formed by the ice, and, after that, the rapid rise of the water. But for the destructive force of storms and the flow of ice in spring, the showing is sufficient to prove that the dumping of ordinary stones, such as are constantly obtained from marine rock blasting, might be sufficient to solve the problem; and it is considered quite possible that these loose stones would remain several years without any cement or anchorage to hold them.

The conclusion reached by the correspondent from this action of the ice is that the proposed dams need not be nearly as complete and expensive as was supposed and that they will produce the desired result.

An enormous landslide occurred in the Himalaya Mountains on the northwestern frontier of British India in 1893, and, by damming up one of the tributaries of the Ganges, formed a lake which threatened great damage to the valley below when it should overflow. The mountain from which the slide occurred is 11,000 feet high, and the material came from a point 4,000 feet above the bed of the stream. The size of the barrier may be judged from the fact that it was 900 feet high, 3,000 feet long across the gorge on top, 600 feet long on bottom, and in cross-section was 2,000 feet at the top, and 11,000 feet at the bottom. The Government took in hand the task of reducing to a minimum the damage from the coming flood. Engineers surveyed the locality and determined by calculation the time when the lake would overflow, fixing a date that afterward proved to be within 10 days of the actual time. Telegraph stations were erected and maintained to warn the people in the valley and piers set in the hill sides 200 feet up from the stream to show them how far they must go to be safe. Other precautions were taken, such as removing steel suspension bridges and substituting temporary rope and wooden structures for them, and carrying out protective measures for the head works of a canal some 150 miles away. Various preparations were made for observations of the yielding of the dam, but it broke during the night (11:30 p. m.), when a heavy fog obscured everything, and by morning the level of the lake had fallen 390 feet. It is calculated that 10,000 million cubic feet of water was discharged in 4½ hours. In an account of the flood *Engineer* says that at the gorge immediately below the dam the flood rose to 260 feet over its ordinary level. The valley was filled up with huge blocks, and the bed of the river was raised some 234 feet, by a substantial weir with a long gentle slope stretching far down the valley. At 13 miles down, the river bed was raised 50 feet by the debris deposited, and the flood reached a height of 160 feet above its ordinary level. All down the valley, for fifty odd miles, the flood rose from 113 feet to 140 feet, causing serious damage. Even at Shrinagar, 72 miles from the landslip, the flood, which was first observed at 3:25 a. m., attained a maximum height of 42 feet above ordinary flood level. Here the damage done was great. The flood reached Hardwar, 150 miles from Gohna, at 8:45 a. m., on Aug. 26, and obtained a maximum height of 11 feet above the ordinary flood level. Fortunately, the main river was low at the time—lower, in fact, than at any time during the previous month. Had the extra Gohna flood arrived on top of one of the very heavy normal floods of the previous 30 days, the canal must have suffered grave disaster. As it was, considerable damage was done.

No lives were lost anywhere in the valley, excepting those of a fakir and his family who had twice been forcibly removed from his hut immediately under the dam and who persisted in returning to it. The self-imposed task of the Government cost it Rs. 2,500,000.

The *Steamship* in its May number, in commenting on the increasing prosperity of the English shipyards, has the following to say about the shipping of other countries: France has made great efforts to encourage shipbuilding by granting bounties, but the result is a marked failure. She pays about £500,000 in bounties to shipping. Germany grants even more than this, but in her case the result is that her shipbuilding is being rapidly extended. At the present time all the yards in Germany are full of orders. Her merchant tonnage is now 1,800,000 tons, which is about double what it was ten years ago. Russia spends over £250,000 in shipping subsidies; her fleet is steadily increasing, but most of the ships are built in Great Britain. Italy pays over £100,000 in bounties, but her shipping and shipbuilding are declining. The United States is making headway in shipping and shipbuilding, and the Government is taking steps to foster the industry. The annual statistics of the Bureau Veritas relating to the mercantile navy of the world give the total number of sailing vessels now afloat, measuring over 50 tons, as 25,570, with an aggregate tonnage of 9,333,995 tons. Of this number, Great Britain comes first with 8,793 ships of 3,333,607 tons. The United States is second, with 3,824 vessels and 1,362,317 tons. Norway is third, with nearly one thousand fewer vessels than the United States, but nearly the same amount of tonnage. In regard to the steamers, England counts 5,771 vessels, with nearly ten million tons. Germany, which comes second, has 826 steamers of 1,306,771 tons. France comes third, with 501 steamers and 864,598 tons. The United States holds fourth place, with 447 steamers and 703,399 tons. These figures relate only to ocean and sea-going vessels, and do not include coasting craft or those employed in lake and inland navigation.

The Effect upon the Diagrams of Long Pipe-Connections for Steam Engine Indicators.*

BY PROF. W. F. M. GOSS.

Errors in indicator diagrams may arise from several causes, one of which is the pipe connecting the indicator with the engine cylinder. It is admitted that, under the conditions of ordinary practice, the presence of the pipe does not constitute the most prolific source of error, but it can be shown that it does cause serious distortion in the form of the diagram, and it is believed that this fact merits more careful consideration than has heretofore been accorded to it. The writer has already called attention to the fact that in road tests of locomotives, where the indicator is attached to a length of pipe sufficient to bring the instrument to the top of the valve box (a length of 3½ feet or more), a true card can be obtained only at slow speeds; and has shown that, for a speed of 300 revolutions per minute, the diagram is likely to be in error as much as 17 per cent.† These early experiments were further used as the basis of a discussion concerning the precise character of the influence exerted by the pipe. They have now been followed by a more extended series of experiments, the results of which are here-with presented.

All experiments were made in connection with a 7½-inch by 15-inch Buckeye engine. The power of this engine was absorbed by an automatic friction brake, by means of which a very constant load was obtained. The head end of the engine cylinder was tapped with two holes (*a* and *b*, Fig. 1), both in the same cross section, and hence equally exposed to the action of the steam in this end of the cylinder. One of these holes (*a*) was made to serve for the indicator *A*, the cock of which was placed as close to the cylinder as possible. The hole *b* was made to receive one end of a U-shaped pipe, the other end of which entered a coupling fixed in the angle plate *c*. The cock of a second indicator, *B*, was screwed to this coupling. A single system of levers supplied the drum motion for both indicators. The closely-connected indicator, *A*, will hereafter be referred to as the "cylinder-indicator," and the cards obtained from it as "cylinder cards." It is assumed that this indicator recorded the actual conditions of pressure existing in the cylinder. In like manner the indicator *B* will be referred to as the "pipe-indicator," and cards obtained from it as "pipe-cards." It is assumed that this indicator gave a record which, when compared with that given by the cylinder indicator, demonstrated the effect of the pipe.

* Abstract of a paper read at the St. Louis meeting of the Amer. Soc. of Mech. Engineers.

† Proceedings of Western Railway Club, March, 1894, page 257.

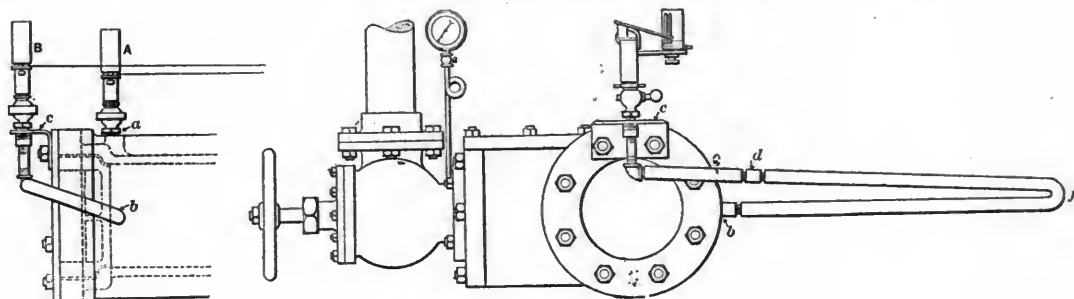
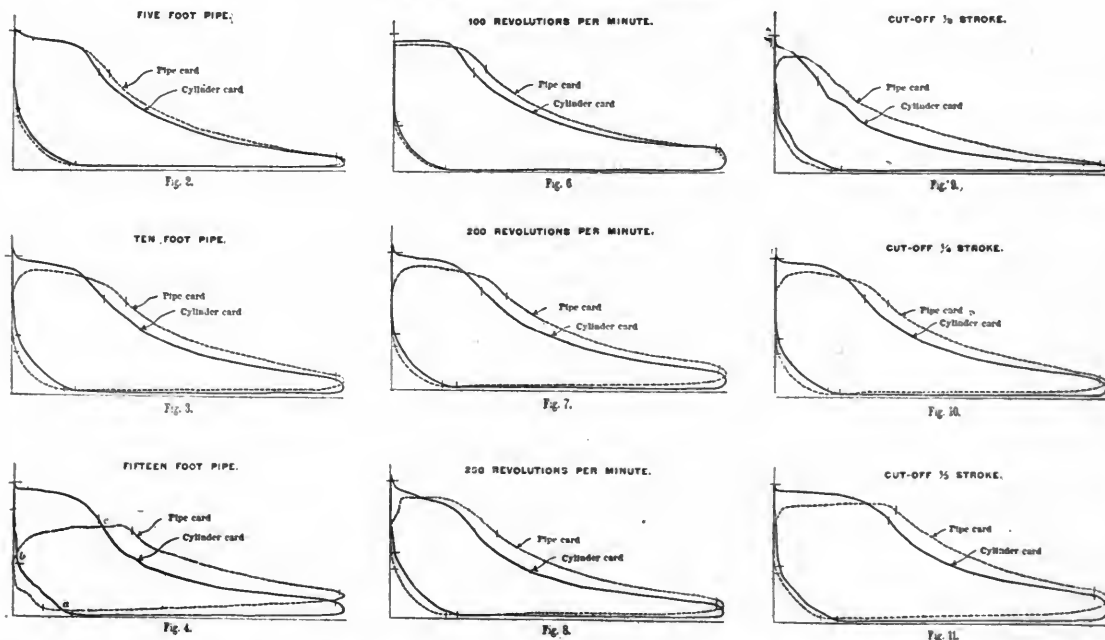


Fig. 1—Method of Attaching Indicators.



The speed (200 revolutions per minute), the steam pressure (80 pounds) and the cut-off (approximately $\frac{1}{4}$ stroke), were constant for above diagrams.

The steam pressure (80 pounds), the length of pipe (10 feet) and the cut-off (approximately $\frac{1}{4}$ stroke), were constant for above diagrams.

The cut off as given above is approximate. The steam pressure (80 pounds), the speed (200 revolutions per minute) and the length of pipe (10 feet) were constant for above diagrams.

Comparison Between Pipe and Cylinder Cards at Various Speeds and Cut-Offs.

The pipe fittings were all half-inch. A right-and-left coupling at *d* allowed the U-shaped section *d f b* to be removed at will and replaced by a similar section of different length. Pipe lengths of 5, 10 and 15 feet were used, length being measured from the outside of the cylinder wall to the end of the coupling under the cock of the pipe-indicator. The pipe and fittings were covered first with a wrapping of asbestos board, next with three-eighths of an inch of hair felt, and finally with an outside wrapping of cloth. It is to be noted that the bend in the pipe at *f* is easy, and that there is a continual rise in the pipe in its course from the cylinder to the indicator. New Crosby indicators were used and were always well warmed before cards were taken.

The results, which are presented in the form of diagrams (Figs. 2, 3, 4, etc.), were obtained in the following manner:

The engine having been run for a considerable period, and the desired conditions as to pressure, speed and cut-off having been obtained, cards were taken simultaneously from the cylinder and the pipe-indicator. Two pairs of cards (*i. e.*, two from cylinder and two from pipe) were thus taken as rapidly as convenient, after which the position of the indicators was reversed, and the work repeated. There were thus obtained four cylinder-cards and four pipe-cards, one-half of each set having been made by one of the indicators, and one-half by the other. Next, by the use of closely

drawn ordinates the eight cylinder-cards were averaged and combined in the form of a single card, and the eight pipe-cards were in the same way combined to form a single pipe-card. The two typical cards thus obtained, superimposed as in Fig. 2, constituted the record of the test. This process was repeated for each of the several conditions under which tests were made. It is proper to add that the accuracy of the indicators used, and the constancy of the conditions maintained, were such as to make each card almost, if not quite, the exact duplicate of the representative of its set.

The diagrams presented are two-thirds size, the spring for all being 60 pounds.

ANALYSIS OF RESULTS.

Different Lengths of Pipe.—The effects produced by the use of pipes between the indicator and the engine cylinder, of five, ten and fifteen feet in length, are shown in Figs. 2, 3 and 4 respectively, the speed, steam pressure and cut-off being constant.

By reference first to Fig. 2, it will be seen that the effect of a five-foot pipe is to make the indicator attached to it a little tardy in its action. Thus, during exhaust, when for a considerable interval of time the change of pressure to be recorded is slight, the lines from the two indicators agree; but during the compression which follows the loss of sensitiveness in the pipe-indicator is made evident by its giving a line which falls below the corresponding

line traced by the cylinder-indicator. Similarly, during admission there is an approximate agreement, while during the expansion which follows the lagging of the pipe-indicator results in a line which is higher than the expansion line given by the cylinder-indicator. As a result of this lagging in the action of the pipe-indicator, its card is in error in the location and curvature of the expansion and compression curves; also in the location of the events of the stroke and in the area which it presents. The speed at which these errors are shown to occur is moderate (200 revolutions), and the length of pipe attached to the indicator is not greater than is often used.

The general effect of a 10-foot length of pipe (Fig. 3) is the same with that of the shorter length, but the lagging action due to the pipe is more pronounced, and all errors are proportionately greater. The total range of pressure recorded upon the cards is less than the range existing in the cylinder.

A still further addition to the length of the pipe brings changes (Fig. 4) into the form of the pipe-card diagram which, while entirely in harmony with those already discussed, are of such magnitude that the form of the card loses some of its characteristic features. The admission and expansion lines are lower, and the exhaust line is higher, than are the corresponding lines for the true card. Fur-



Fig. 5

thermore, while cards from pipes of five and ten feet in length present an area greater than that of the true card, the card from a 15-foot length of pipe makes the area less. It is evident that a pipe of suitable length would result in a diagram somewhat similar in form to that shown by Fig. 5; a pipe still longer would give a card which would be represented by a single line, as AB, Fig. 5.

It is true that the lengths of some of the pipes experimented with are excessive as compared with those commonly used for the connection of indicators, but this fact does not deprive the results of their significance. If pipes of fifteen, ten and five feet in length will produce the effects shown by Figs. 4, 3 and 2, respectively, it is but reasonable to suppose that pipes of less than five feet in length will produce some effect. And, since the effect of a five-foot pipe is considerable, this length must be greatly reduced before the effect ceases to be measurable.

[The author next explains the cause of the slight differences in form between the cylinder diagrams taken under the same conditions. These are attributed to changes in clearance produced by the different lengths of pipes leading to the other indicator, the greater surfaces exposed to the steam in the longer pipes, and to the flow of steam in and out of these pipes. He concludes that the existence of these differences in the cylinder diagrams does not in any way affect the results the paper is designed to present. Each cylinder card is true for the conditions under which it was taken.]

The Effect of the Pipe at Different Speeds.—The effects thus far discussed are those recorded for a constant speed of 200 revolutions per minute. In considering to what extent changes of speed will modify these results, reference should be made to Figs. 6, 7 and 8, which give a series of results for which all conditions were constant except that of speed. It will be seen that increase of speed produces modifications in the form of the pipe-diagrams which, in kind, are similar to those produced at constant speed by increasing the length of the pipe, but these changes are not great. For example, increasing the speed from 100 to 200 revolutions per minute (Figs. 6 and 7) produces less change than increasing the length of the pipe from 5 to 10 feet (Figs. 2 and 3). The fact that an engine runs slowly, therefore, does not seem to justify the use of an indicator at the end of a considerable length of pipe. Slow running reduces the error; it cannot be depended upon to eliminate it entirely.

The Effect of the Pipe at Different Cut-Offs.—The relative effect of the pipe at different cut-offs, other conditions being constant, is shown by Figs. 9, 10 and 11. It will be seen that the differences of pressure recorded during expansion by the two indicators (pipe and cylinder) are approximately the same for all cut-offs; but the relative effect of these differences upon the area of the diagram is most pronounced upon the smallest, or shortest, cut-off card. The fact that in Fig. 11 the steam line on the pipe-card rises while that of

the cylinder-card declines, constitutes a good illustration of the slowness with which the pressure in the pipe responds to that in the cylinder. The following conclusions constitute a summary of the data already presented:

1. If an indicator is to be relied upon to give a true record of the varying pressures and volumes within an engine cylinder, its connection therewith must be direct and very short.
2. Any pipe connection between an indicator and an engine cylinder is likely to affect the action of the indicator; under ordinary conditions of speed and pressure, a very short length of pipe may produce a measurable effect in the diagram, and a length of three feet or more may be sufficient to render the cards valueless except for rough or approximate work.
3. In general, the effect of the pipe is to retard the pencil action of the indicator attached to it.
4. Other conditions being equal, the effects produced by a pipe between an indicator and an engine cylinder become more pronounced as the speed of the engine is increased.
5. Modifications in the form of the diagram resulting from the presence of a pipe are proportionately greater for short cut-off cards than for those of longer cut-off, other things being equal.
6. Events of the stroke (cut-off, release, beginning of compression) are recorded, by an indicator attached to a pipe, later than the actual occurrence of the events in the cylinder.
7. As recorded by an indicator attached to a pipe, pressures during the greater part of expansion are higher, and during compression are lower, than the actual pressures existing in the cylinder.
8. The area of diagrams made by an indicator attached to a pipe may be greater or less than the area of the true card, depending upon the length of the pipe; for lengths such as are ordinarily used, the area of the pipe cards will be greater than that of the true cards.
9. Within limits, the indicated power of the engine is increased by increasing the length of the indicator pipe.
10. Conclusions concerning the character of the expansion or compression curves, or concerning changes in the quality of the mixture in the cylinder during expansion or compression, are unreliable when based upon cards obtained from indicators attached to the cylinder through the medium of a pipe, even though the pipe is short.

Bechem & Post's System of Water-Spray Firing.*

BY ADOLPH BECHEM.

A water-spray ventilator, manufactured by Mr. F. Kluge, of Barmen, having been adapted to a soldering stove, it was observed that the fire became so fierce that a soldering-tool placed in it speedily became partially melted. The draught in the case of a smith's forge provided with this spray-ventilator produced a much greater heating effect than had previously been obtained by means of a Root's blower with a manometric pressure equal to 15.7 inches of water; the equivalent draught with the water-spray ventilator being only 0.12 inch. The author was led, on this account, to attribute the rise in temperature to the decomposition of the minute globules of water and the combustion of the resultant gases. He accordingly purchased Mr. Kluge's patent for firing purposes. Attention is directed to the various ways in which water can be employed as fuel and its use in the production of so-called water gas. When utilized as steam in the form of the steam-jet, water is much less effective as fuel in consequence of the fact that one molecule of water occupies the space of 1,700 molecules of steam, and thus the chemical energy of steam is only the $\frac{1}{1700}$ part of that of water. The peculiar value of the water-spray as fuel lies in the fact that the finely divided drops of water come into far more intimate contact with the carbon on the hearth than the more elastic particles of steam and, moreover, as air is needed to support combustion, and as steam is at even temperatures specifically much lighter than air, there is, in the case of the steam-jet, a tendency on the part of the steam to separate itself from the atmospheric air, to rush forward to the fuel, and to prevent the free access of air to the carbon. Experiments with various kinds of fuel—coal, coke, etc.—in a smith's forge, have demonstrated that the water-spray is capable of producing the highest possible temperatures; the special arrangement of the jet for this purpose are explained. The use of the water-spray under fire-bars is extremely beneficial, as they are thereby kept cool and become rapidly protected by a coating of oxide, which serves as a preservative; there is, moreover, scarcely any perceptible waste in the bars. Experiments have also been made with the use of the water-spray on a large scale for blast furnaces and other manufacturing purposes, and it is also capable of being used under certain conditions in domestic stoves.

The air-pressure needed to produce the spray is very moderate, even that due to water at a height of 33 feet suffices. The amount

* Abstract in *Proceedings of Inst. of Civil Engineers* of article in *Gesamtheit Ingenieur* of July 31, 1895.

of water which can be consumed in the spray form varies, of course, with the size of the fireplace from two to six gallons per hour.

The advantages of this system of firing are thus summed up by the author: Great economy of fuel, absolute freedom from smoke, immediate production of extreme temperatures up to the melting point of platinum, adaptability of every description of fuel for the purpose, applicability of the system to all kinds of firing needed for industrial and domestic operations, and, lastly, the possibility of replacing by this means all existing regenerative systems and all plant adapted for firing with powdered coke, coal, etc.

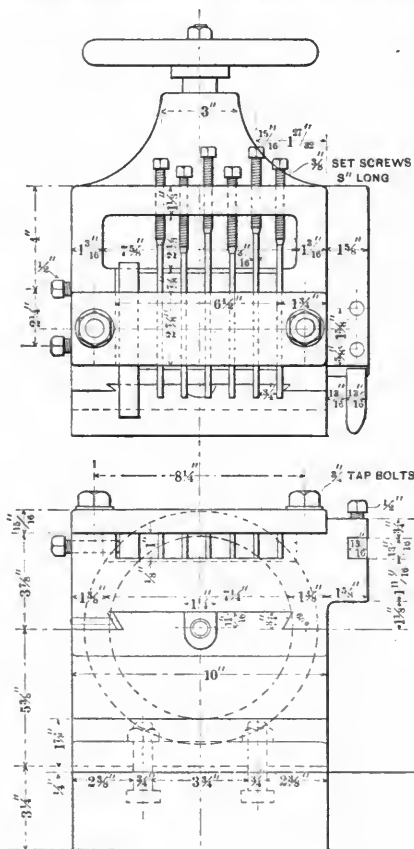
[These experiments seem to have a very important significance. There is a popular impression among firemen, which is very general, that wetting coal improves combustion. Besides doing this, it serves the purpose of preventing dust, and with very fine coal

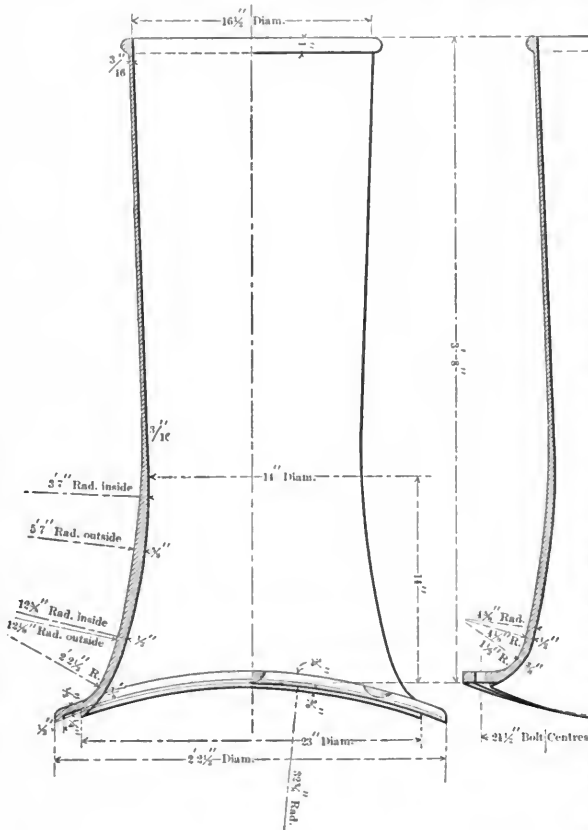
Multiple Tool Post for Turning and Cutting-off Piston Packing.

The excellent practice of comparing costs of work in the various shops of the same railroad system led indirectly to the design of the multiple tool holder for turning and cutting-off packing shown herewith. In making such comparisons on the Chicago-Milwaukee & St. Paul system it was found that piston packing was produced at some of the shops for less than it cost at the West Milwaukee shops. Not to be outdone, the tool shown was designed for the work, and as a result packing for an 18-inch engine is turned out at a total cost for labor of 23 cents.

The tool holder is of special form and is mounted on the carriage of the lathe just ahead of the regular tool holder and well out toward the apron. It is provided with a transverse hand feed. It is made to carry six cutting-off tools and one turning tool. The cutting-off tools are made of 1-inch by $\frac{3}{8}$ -inch steel and are separated by spacing blocks exactly $\frac{1}{4}$ inch wide and nearly 1 inch thick. After the last cutting-off tool is a plain bar of steel, separated from it by a $\frac{1}{4}$ -inch spacer. This is for gaging the thickness of the first ring, as will be explained. These tools and spacers are held by a single clamp extending across them all and by two set screws, which bind them laterally. Each tool is adjusted toward the work by a set screw back of it.

The packing is turned on the outside by the turning tool shown in advance of the cutting-off tools. The outside being finished, the carriage of the lathe is advanced until the bar of steel adjacent to the cutting-off tools touches lightly the face of the casting. All the tools are then fed in together and six rings cut off at once. The tools are so carefully made that the sides of the rings are perfectly smooth, and do not need facing either for finish or to bring them to size. The tools are each set slightly in advance of its left hand neighbor, so that the rings come off one





Cast Iron Smoke Stack.—C. & N. W. Ry.

pressure being of equal size. The whole of the five cylinders are arranged in line, and connected to five cranks, the cranks being set at equal angles throughout the circle, i. e., 72 degrees apart. The cylinders are respectively 17 inches, 24 inches, 34 inches, 42 inches and 42 inches in diameter.

The steam for the engines is supplied from boilers working at a pressure of 235 pounds on the inch. These are of the ordinary cylindrical multi-tubular type, and were tested by Lloyd's to 510 pounds per square inch. They are fitted with Mr. Mudd's system of superheating apparatus, combined with the well-known Ellis and Eaves' type of induced draught, and with Serve tubes and retarders. An attempt is here made not only to supply the engine with dry steam from the boilers, but to retain it in a dry state throughout the engine; and to this effect there are combined with the superheater an apparatus that Mr. Mudd calls an initial receiver, an exceptionally complete system of steam jacketing to the cylinders, and an exhaust control arrangement.

There is also an unusually elaborate scheme of feed heating. Instead of the usual single vessel, there are a series of feed heaters worked at graduated temperatures, and as the water passes through these it continues to rise in temperature until on entering the boilers it is nearly at the temperature of the steam. On the trials the thermometers registered about 400 degrees Fahrenheit as the temperature of the feed water as it passed the meter and entered the boilers. The feed-water filters are the Edminston patent, and Mudd's evaporator is used.

The five-crank system does not, as might be supposed, involve any great increase in length of engine-room space, as the reduced diameters of cylinders allow the centers to be closer. In the case of the *Inchmona*, the engine-room is only one frame space longer than for the same power in three-crank engines. The five-crank principle is put forward by the builders as most suitable for large powers and for long-voyage boats, where economy of fuel is of such vital importance. If the predictions of the builders are realized it will mean that some 500 or 600 tons of coal can be saved

on the single round voyage to Australia or New Zealand of a cargo boat carrying 6,000 or 7,000 tons, at a speed of eleven knots.

The designers of the engines confidently anticipate that, by means of the various improvements effected, the consumption of coal will be brought down to a figure closely approximating to 1 pound per I. H. P. per hour.—*The Practical Engineer*.

Cast Iron Smoke Stack—Chicago & Northwestern Railroad.

In the accompanying drawing we show the standard cast-iron stack of the Chicago & Northwestern Railroad. The stack and base are all in one casting with the holes eored for securing it to the smokebox, so that there is no labor whatever expended on it, except to put it in place and paint it. Three patterns suffice for all engines. A single pattern is used for stacks of various lengths, the diameter at the base and throat and the taper being maintained while the diameter at the top depends upon the length. The stacks average somewhat more than 300 pounds in weight. As the castings cost three cents per pound (a special price for this particular line of work) the cost of the stack on the engine is less than ten dollars.

The Comparative Cost of Pintsch and City Gas for Car Lighting.

A valuable report on the cost of lighting passenger cars with city gas was recently made to Mr. R. H. Wilbur, General Superintendent of the Lehigh Valley Railroad, by Professors W. H. Chandler and J. E. Denton. The railroad company had in contemplation the problem of lighting their passenger equipment with gas, and had given some consideration to the plan of using city gas, burned in Gordon-Mitchell lamps. The Safety Car Heating and Lighting Company had made the road a proposition to furnish a generating and compressing plant for Pintsch gas, at Phillipsburg (just across the river from Easton), and operate it, covering all labor and expense necessary to charge the cars with sufficient gas to afford the same illumination as with the city gas, at the rate of \$5.09 per thousand cubic feet stored on the cars. The object of the investigation and report was to determine which of the two propositions was the more economical.

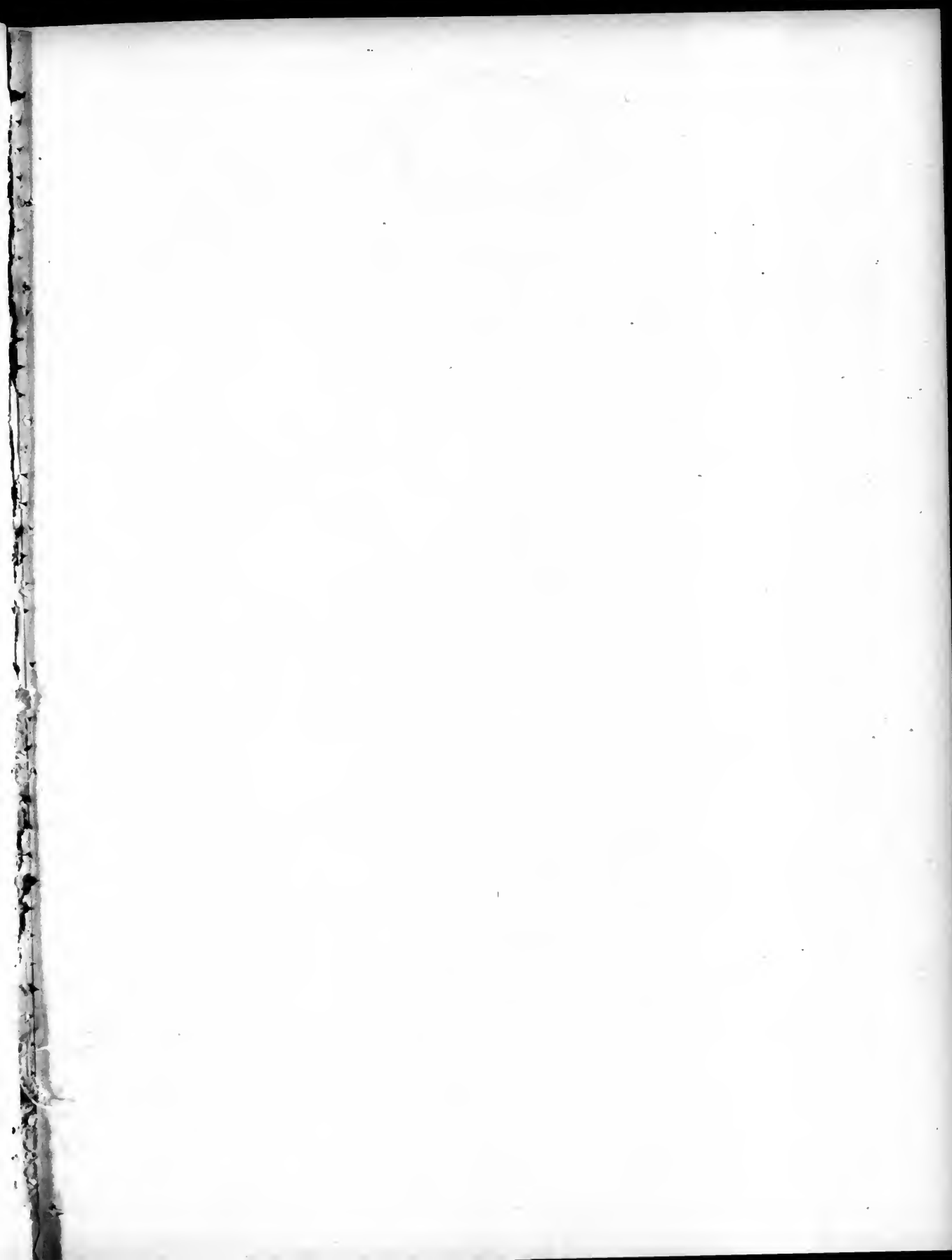
The illuminating power of the city gas obtainable at Phillipsburg was assumed to be the same as that of Jersey City, which when burned uncompressed in an Argand burner at about 60 degrees Fahrenheit gave 5.23 candle power per foot. In the same burner, after compression to 17 atmospheres, it lost 54.2 per cent. of illuminating power. The Pintsch gas compressed by the experimenters at the Delaware, Lackawanna & Western Railroad Company's gas works, at Hoboken, to 12 atmospheres, when burned in the same burner, gave before compression 10.25 candle power per foot, and after compression lost only 4.4 per cent. of light.

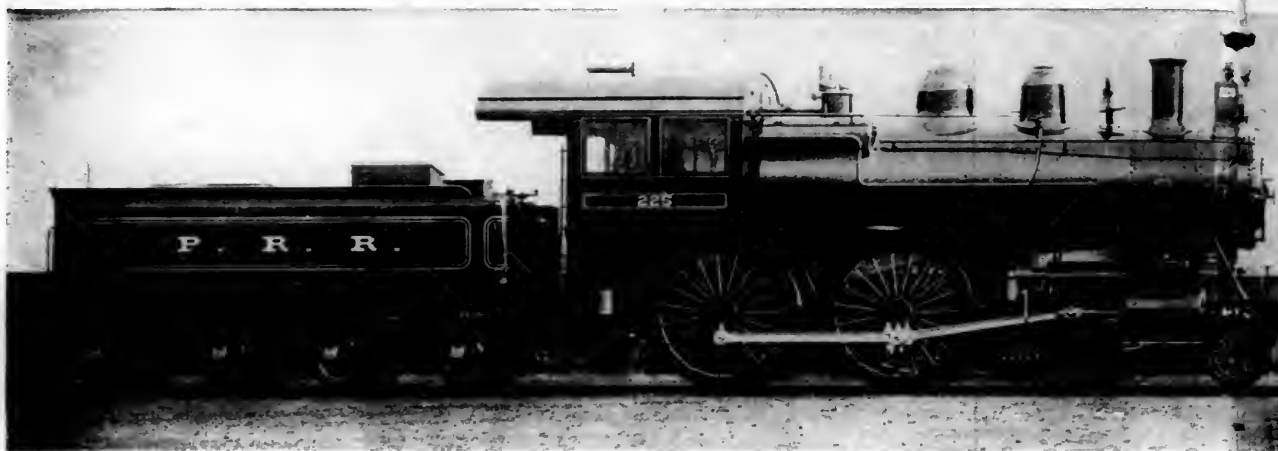
The city gas when burned in Gordon-Mitchell lamps at the rate of 7.6 cubic feet, per hour gave about 29 candle power per lamp at 45 degrees, and for the 174 cars to be supplied at Easton and Phillipsburg there would be required 18,872 cubic feet per 24 hours. The Pintsch gas if burned in the Pintsch four-flame lamp or in their Argand burner would be consumed at the rate of 3.4 cubic feet per hour, consequently in the same number of lamps as used for the city gas the total consumption would be 8,443 cubic feet per 24 hours. The candle power would, however, be considerable more, being 54 candle power per lamp for the Argand burner and about 35 candle power for the four-flame lamp.

A comparison is first made between the two systems upon the basis of a consumption of 18,872 cubic feet of city gas and 8,443 cubic feet of the Pintsch gas. The lowest cost of compressed city gas at Easton is given at \$2.883 per thousand, as follows:

LOWEST COST OF COMPRESSED CITY GAS AT EASTON FOR CONSUMPTION BY LAMPS OF 18,872 CUBIC FEET PER 24 HOURS.			
Average of Summer and Winter Consumption.			
Coal for compressing, at \$1.75 per gross ton	4.20c.	per thousand.	
Water for compressing, at \$1.00 per 1,000 cubic feet	1.19c.	"	
Labor for filling cars and compressing	47.27c.	"	
Material for repairs of charging system	14.40c.	"	
Interest and depreciation on cost of compressing plant	17.50c.	"	
Interest and depreciation on extra investment for car tanks using city gas over that required for tanks using Pintsch gas	15.65c.	"	
Cost of city gas equivalent to Jersey City gas delivered to compressing stations at \$1.50 per M, including extra cost due to unavoidable loss by leakage between compressor and cars of 20 per cent. of total gas	188.00c.	"	
Total cost of city gas on cars at 270 pounds pressure	\$2.883	"	

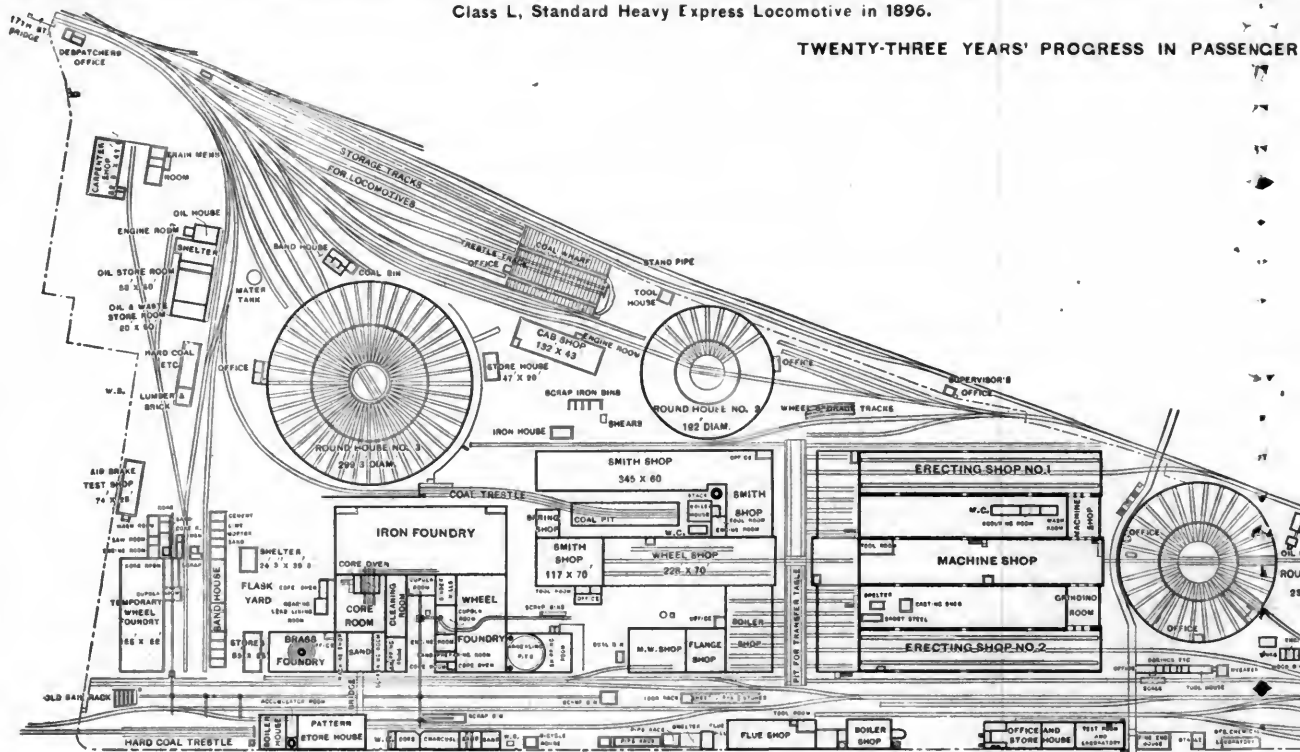
The items comprising the above statement were obtained as fol-



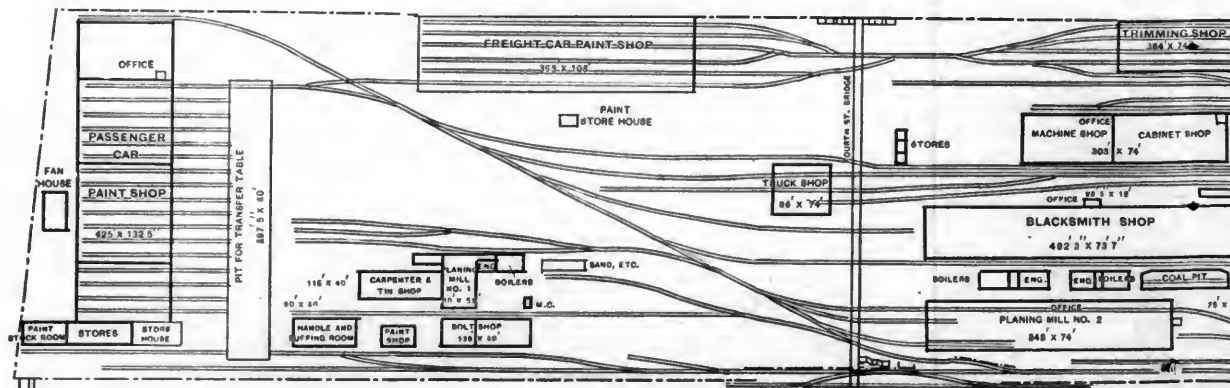


Class L, Standard Heavy Express Locomotive in 1896.

TWENTY-THREE YEARS' PROGRESS IN PASSENGER



PLAN OF LOCOMOTIVE REPAIR SHOPS, ALTOONA, PA.



PLAN OF CAR SHOPS OF THE PENN. R.R.

lows: The size of the compressing plant needed was first determined. In compressing the gas to 20 atmospheres and delivering it on the cars actual tests demonstrated there would be a loss through leakage and liquefaction of 20 per cent., of which 14 per cent. was for leakage alone. In a compound or two-stage compressor (which is the type recommended for the work) actual tests show the delivery of gas at 20 atmospheres does not exceed 57 per cent. of the piston displacement.

It was further found by observation at a point where about 100 cars are charged every 24 hours and 22,000 cubic feet of gas pass through the compressors that two-thirds of the gas is compressed during the day, and also that the maximum demand upon the compressors is about twice the average for the daylight hours. Taking all these facts into consideration, the required piston displacement of the compressors is found to be about 5,000 cubic feet per hour and two compressors of 2,500 cubic feet are recommended. These would run at 75 revolutions, but could be speeded up to 150 in emergencies. The price of each compressor is placed at \$850 and the total cost of the compressor plant is given as follows.

Two compressors at \$850.....	\$1,700
Connections.....	50
Foundations.....	50
Labor of erecting.....	50
Building.....	244
Total.....	\$2,094

Tests of a similar gas compressor showed that the indicated horse power per 1,000 cubic feet piston displacement at 20 atmospheres per hour was about 3.8 horse power. To displace at the rate of 2,500 cubic feet would therefore require 9.5 horse power. To pump from one storage reservoir into the others at the same rate would probably require 50 per cent. as much power, or 4.75 horse power, which added to the other would give a total of 14.25 horse power. Experiments show that 45 pounds of water must be evaporated per horse power to 60 pounds pressure, or 641 pounds of steam per hour. This would necessitate a boiler of about 22 nominal horse power with 10 square feet of grate and 300 square feet of heating surface, costing \$300 set up and connected; adding \$250 for the building makes the total cost of the boiler plant \$550. If the company's boilers already at Phillipsburg can supply the steam this item can of course be omitted.

The storage capacity at the compressing station is taken at a figure large enough to charge a Buffalo train of three coaches and two sleepers at Easton in ten minutes, without interrupting the charging of cars in the yard. The Buffalo train would require 2,736 cubic feet and to charge a train of three coaches in the yard that were three-quarters exhausted would require 776 cubic feet. If such a train had to be charged within 20 minutes after the Buffalo train the total gas required in that period of time would be 3,512 cubic feet. Of this amount the compressors could pump in that time 1,000 cubic feet, leaving 2,512 cubic feet to be supplied from the reservoirs. To do this the reservoirs must have a capacity of 1,256 cubic feet. Five reservoirs 50 inches in diameter and 20 feet long would suffice, and their cost would be as follows:

Five reservoirs.....	\$4,000
Valves and fittings.....	1,250
Foundations and shed (to protect reservoirs from sun heat).....	300
Labor of erection.....	100
Total.....	\$5,650

The pipe lines necessary to charge cars at Phillipsburg and Easton are computed to cost \$2,972.

The cost of extra tank storage on the cars to hold the greater volume of city gas is given at \$55 per car with five lamps, or for 174 cars \$9,570. This estimate is based on one tank of 18.6 cubic feet capacity for Pintsch gas, containing enough gas for 14 hours' consumption, and two tanks of 14.5 cubic feet capacity for the city gas.

Combining the above items, the total investment for the use of city gas is found to be as follows:

Compressors, buildings and foundations for same.....	\$2,094
Boiler, erected and housed.....	550
Storage reservoirs, erected and housed.....	5,650
Pipe lines and charging-fittings, in place.....	2,972
Investment for compressing plant.....	\$11,266
Additional cost of car-tanks for 14 hours burning supply, using city gas, over that with Pintsch gas.....	9,570
Total investment.....	\$20,836

The cost of operation was investigated in the same careful manner. It was found that the coal burned per 1,000 cubic feet of gas compressed for the lamps was 54.4 pounds, which at \$1.75 per gross ton cost 4.25 cents per thousand. The water per thousand feet of gas compressed was 11.9 cubic feet, including jacket water for the compressor cylinder, which at \$1.00 per thousand cost 1.19 cents.

The labor at the compressors and boiler house is placed at 21.46 cents per thousand feet if a separate boiler plant was required, and 19.37 cents if steam was taken from other boilers. For filling the cars it was found in another yard, where about 25,000 cubic feet is made per 24 hours, it was found that 3 day men working 12 hours at 14 cents per hour, and one night man working 12 hours at 11 cents per hour, were needed in winter. In summer 2 day men at 14½ cents and one night man at 11 cents did the work. Other yards were examined, and it was concluded that one day and one night man would be required at Easton, and one day man at Phillipsburg all the year round, making the cost of labor for filling 24.8 cents per thousand in winter, and 31 cents in summer (when the consumption would be 20 per cent. less than in winter) or an average of 27.9 cents throughout the year.

The cost of material for repairs was determined from the records of the Safety Car Lighting and Heating Company, no railroad records being available. It was found to be 14.4 cents per thousand.

Interest was taken at 6 per cent. and depreciation at 4 per cent., amounting to 18.41 cents if the separate steam boilers had to be used and 17.5 cents if they were not installed. The interest and depreciation on the extra tanks needed on the cars for the city gas must be added to this, it being 15.65 cents.

The city gas can be obtained at \$1.50 per thousand feet from the city mains, but the loss from leakage and shrinkage already noted brings the cost per thousand feet actually consumed to \$1.88.

We have now given the derivation of all of the items mentioned in the table, showing the total cost of the city gas on cars as \$2.83 per thousand. The illuminating qualities of the two gases are next summarized in the following table:

RESUME OF ALL ILLUMINATING TESTS.

Relative Illumination per Cubic Foot of Gas Burned.

Candle power per cubic foot: Candle power with Gordon-Mitchell lamp, burning city gas at the rate of 7.6 cubic feet per hour, affording about 29 candle power at 45 degrees.

Tests in which photometer-disc was at equal distances from floor of car in tests of four lamps.

Lamp compared.	Cubic feet of gas per hour.		Relative illumination per cubic foot of gas burned.		
	Candle power at 45 degrees.	Tests with single.	Tests with four.	Average.	
1.	2	3	4	5	6
1. Gordon-Mitchell lamp, burning Pintech gas.....	3.36	26.0	2.07	2.06	2.06
2. No. 1 Pintech Argand lamp, burn- ing Pintech gas.....	3.41	54.3	4.42	3.76	4.09
3. No. 1 Pintech Argand lamp.....	7.13	30.4	1.22	0.98	1.10
4. Four-flat flame Pintech lamp, burning Pintech gas*.....	.....	.....	3.12	2.73	2.92
Average.....	3.31	35.4	Aver. 3.02	.....	Aver 2.87
5. Four-flat-flame Pintech lamp, burning Pintech gas*.....	.....	.....	2.92	2.73	

Tests in which photometer-disc was at equal distances below the lamp flame centres in tests of four lamps.

6. Gordon-Mitchell lamp, burning Pintsch gas.....	3.36	26.0	2.07	2.16	2.11
7. No. 1 Pintsch Argand lamp, burning Pintsch gas.....	3.41	54.3	4.42	3.44	3.93
8. No. 1 Pintsch Argand lamp, burning city gas.....	7.13	30.4	1.22	0.89	1.05
9. Four-flat-flame Pintsch lamp, burning Pintsch gas*.....	.....	.....	3.12	2.50	2.81
Average.....	3.31	35.4	Aver. 3.02	.....	} Aver 2.76
10. Four-flat-flame Pintsch lamp, burning Pintsch gas*.....	2.92	2.50		2.71

In tests marked * the four-flat flame Pintsch lamp was set so that each of the four flames are at an angle of 45 degrees to a vertical plane passing through the centre of the lamp and of the photometer-disc.

In tests marked † the lamp was set so that one of the four flames was toward, and parallel to, a vertical plane passing through the axis of the photometer-disc.

The following conclusions are drawn from the data presented above:

1. If 1,000 cubic feet of Pintsch gas was burned in the Pintsch Argand lamps while the latter afforded the illumination corresponding to about 54 candle power for a certain number of burning

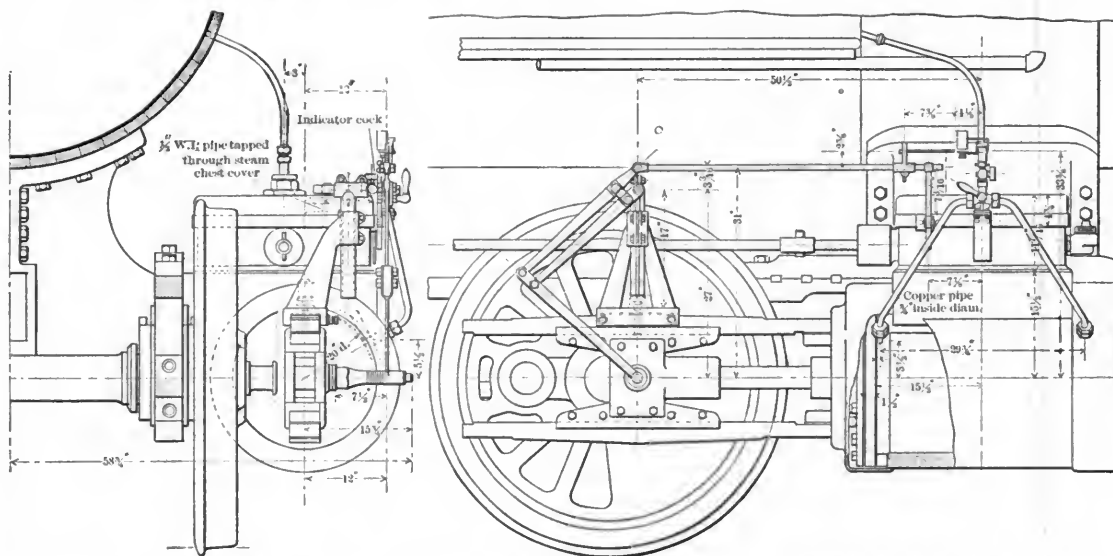


Fig. 1.—General Arrangement of Indicator Rig Applied to a Class R Locomotive.—Pennsylvania Railroad.

hours, then, by line 7, column 4, of the above table, 3,930 cubic feet of city gas must be burned in the Gordon-Mitchell lamps, affording about 29 candle power at 45 degrees, in order to obtain the same total amount of illumination. The cost of obtaining this illumination from the Pintsch lamps would be \$5.00 per M; and from the Gordon-Mitchell lamps, $2,883 \times 3.93 = \$11.33$ per M.

In other words, the Pintsch gas might be sold at \$11.33 and be as cheap per unit of illumination as the city gas at its cost of \$2.883 per thousand scored on the cars. In view of the large difference in candle power of the two lamps, however, equal illumination could not be afforded by them in a car, unless there were nine Gordon-Mitchell lamps to about five Pintsch lamps. Under this arrangement the relative cost of the equal illumination would not be practically altered from the above figures. Such a difference in the number of lamps is, of course, impracticable, so that a use of the Pintsch Argand lamps with Pintsch gas must be accompanied with greater illumination in the car than is obtained from an equal number of Gordon-Mitchell lamps at the service rates of consumption for each which was used in the experiments.

If we do not attempt to represent the difference of the light in the cost of the gas, the comparative cost of the two systems may be represented by the cost per car hour.

This cost, using five Pintsch Argand lamps with Pintsch gas, affording about 54 candle power at 45 degrees, at \$5.00 per M, is 8.7c. per car hour.

The similar cost for five Gordon-Mitchell lamps, affording about 29 candle power at 45 degrees, with gas at \$2.883 per M, is 11.0c. per car hour.

Therefore, the use of the Pintsch Argand system costs, for gas, about 20% less per car hour than the Gordon-Mitchell system, and affords about 70% more illumination below the horizontal; the candle power at 45 degrees representing about the average intensity of the light over its lower hemisphere of action. The equivalent annual saving by using the two lamps, therefore, neglecting the fact that the Pintsch lamp affords this extra amount of illumination, is as follows:

The average consumption of city gas would be 6,199,525 cubic feet per annum, costing \$17,873. The equivalent amount of Pintsch gas would be 2,761,629 cubic feet per annum, costing \$14,158. There would, therefore, be an annual saving of \$3,715 per annum by the use of the Pintsch Argand system, as compared to the Gordon-Mitchell system, with an illumination proportional to about 29 candle power from the latter system as compared with an illumination proportional to 34 candle power from the Pintsch system.

II. Comparing the Gordon-Mitchell lamp using city gas with the Pintsch four-flat-flame lamp consuming 3.31 cubic feet per hour, affording 35.4 candle power at 45 degrees, the annual costs are as follows:

The total city gas consumed per annum would be 6,199,525 cubic feet, costing \$17,873 as before. The total Pintsch gas consumed per annum would be 2,700,036 cubic feet, which would cost \$13,743. The use of the Pintsch four-flat-flame lamp would, therefore, save \$4,130 per annum over the use of the Gordon-Mitchell lamp with city gas, or the cost of the Gordon-Mitchell gas equals that of the Pintsch gas bought at \$6.03 per thousand, and the Gordon-Mitchell lamps afford 20 per cent. less illumination in the most useful direction in the car. If the gas consumption of the four-flat-flame lamp was restricted so that its candle power should be practically the same at 45 degrees as that of the Gordon-Mitchell lamp, the annual saving would be \$6,370, or, in other words, the cost of the city gas in Gordon-Mitchell lamps is equivalent to Pintsch gas at \$7.90 per thousand.

A Substantial Indicator Rigging for Locomotives.

The more frequent use of the indicator on locomotives has resulted in more carefully designed and better indicator rigs. When indicating locomotives was a novelty in which the master mechanic or chief draftsman indulged about once a year, the cheapest rig that would hold together for that particular time was good enough; now on large railroad systems a substantial rig is desired, and one that is adjustable to many classes of engines. For this reason we think our readers will be interested in the latest rig used on the Pennsylvania Railroad and shown in the accompanying illustrations.

Fig. 1 shows the general arrangement and the manner of applying it to a "Class R" consolidation locomotive. Figs. 2 and 3 give some of the important details. The indicator drum is driven by means of a parallel motion attached to the cross-head pin and supported on an adjustable standard on the top guide. To attach this standard the guide oil cup is removed and an oil stud inserted which bolts the standard down and into the top of which the oil cup is placed. The standard has flanges extending down each side of the guide and is further secured by two pointed set screws in the front flange. The face of the guide has conical recesses to receive the points of the screws. In the upper end of the standard is clamped a vertical cast iron column 2 inches in diameter which is adjustable in height and prevented from turning by a key. The upper end of this column carries a horizontal shaft 1½ inches in diameter which can be firmly clamped and is adjustable laterally. At its outer end it has a journal 1 inch by 2 for the upper end of one of the long links of the parallel motion.

The various parts of this parallel motion, except the pins and bushings, are shown in detail in Fig. 2. They are all wrought iron cast hardened, and the holes A, B, C, D and E are provided with bushings. These are a driving fit in the two upper links in Fig. 2, and a working fit in the holes correspondingly lettered in the other links. The bushings are a shade longer than the total width of the links through which they pass, so that the ¼-inch bolts inserted through them hold the parts together without binding. The attachment to the crosshead is effected by removing the nuts on the crosshead pin, and in their place putting on first a hexagonal check-nut ¼ inch thick and then screwing on the extension piece shown in Fig. 2. This has a 3-inch by 1-inch journal, which can be adjusted laterally 2½ inches by means of the leather washers shown.

The indicator three-way cock is firmly bolted to a bracket on

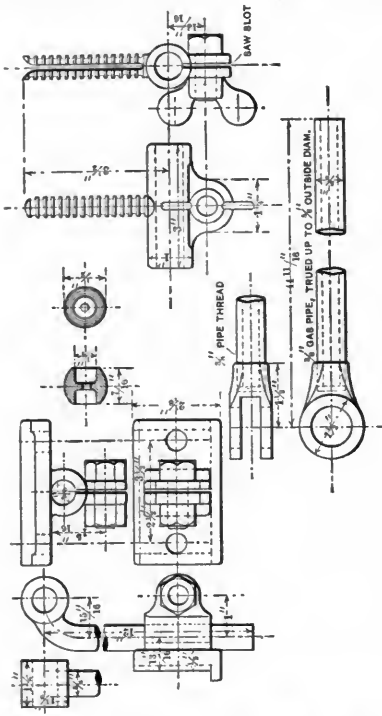


Fig. 3.

the outside face of the steam chest casing. It is placed as low down as convenience of operation will permit, and being outside of the casing, the pipes to it are more direct and shorter than usual. The cock is piped to the steam chest also. The connection from the parallel motion to the indicator arm consists of a long piece of $\frac{1}{4}$ -inch iron pipe, with a jaw at its rear end and supported at the front end by an adjustable standard attached to the face of the steam-chest casing. Clamped on to this pipe is an upright pin that is split for the cord and is grooved on the outside to keep the small brass button on the end of the cord from slipping. To connect the cord it is only necessary to pull it out and drop it through the slit in the pin. Disconnecting it is equally easy. This neat arrangement will be appreciated by those who have experienced the difficulties of taking cards at high speeds. The details are shown in Fig. 3.

From our description and the illustrations it will be seen that this rig is not only convenient and durable, but it is adjustable in every direction and can be attached to locomotives varying considerably in dimensions. The motion to the drum is perfect, the cord is short and easily connected, and the steam pipes are short and direct. Altogether it is excellent. Mr. A. W. Gibbs, engineer of tests, states that some of the ideas were obtained from the rig used by Professor Goss on the locomotive at Purdue University, but this rig had to be adapted for road service and the features pertaining to the adjustment to various engines and the attachment for the cord are new.

A New Water-Tight Bulkhead Door for Steamships.

In connection with the construction of battleships, as well as of mercantile vessels, there has always been room for improvement in the matter of bulkhead doors. So important a point is it, in fact, that some time ago the British Admiralty appointed a Commission to consider the subject, with the object of adopting some plan whereby the risks run through the water-tight doors being left open would be minimized. The terrible disaster to the British battleship *Victoria*—which might have been averted had the bulkhead doors been closed—has only to be remembered to show the great necessity for adopting some method of preventing occurrences of the kind. It would seem that now the difficulty has been solved, for Mr. Wm.

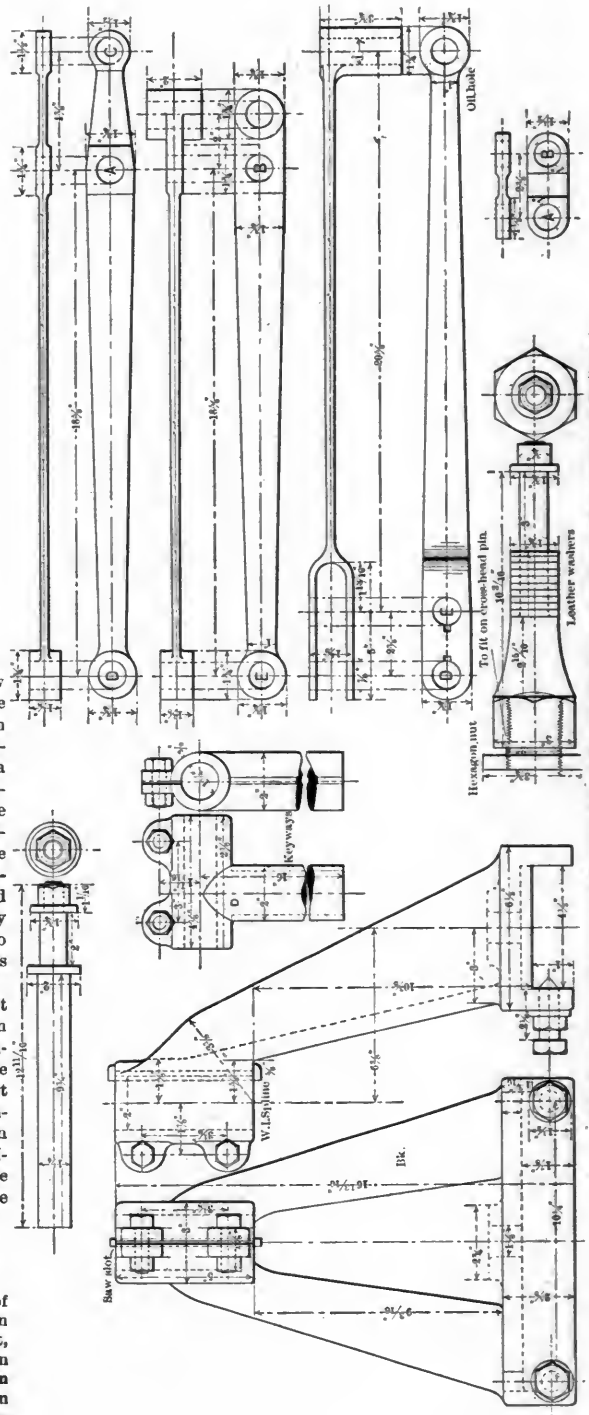


Fig. 2.—Details of Indicator Rig for Class R and Other Locomotives.—Pennsylvania Railroad.

Kirkaldy, of Glasgow, has invented a bulkhead water-tight door which it is absolutely impossible to leave open. The feature of Mr. Kirkaldy's patent door is its wonderful simplicity. It consists of a hollow cylindrical door, which revolves within a suitable casing, fixed to, or forming part of, a water-tight bulkhead. By combining this revolving cylindrical door and casing a double-door is formed, which effectually prevents the ingress of fire, water, etc., through the bulkhead, yet on being revolved by hand allows free thoroughfare between water-tight compartments, with the certainty that at all times and under all conditions *one of the doors is absolutely closed*, thus guaranteeing that the bulkhead is intact and thoroughly reliable in the event of a sudden disaster. When the doorways in casing and the revolving cylindrical door are in line free passage through the bulkhead is gained by entering and standing inside of the casing and revolving it by hand, when the ingress doorway in casing is absolutely closed before the opening in the revolving door comes in line with the second doorway to allow egress from the casing. In the event of a collision there is absolutely nothing to be done in the way of closing the water-tight doors. As the doors are never open no gearing is required to close them, thus obviating the necessity of bulkhead drill, and allowing the crew to perform other urgent work. The invention has been shown to a number of naval and engineer experts and others interested in shipping matters, who have expressed their approval of its merits and the exceptional features of safety which the door possesses.—*The Steamship.*

Successful Trial of Professor Langley's Aerodrome.

Some of the best contributions to the science of aerial navigation have come from Professor Langley, Secretary of the Smithsonian Institution, and it is well known that he has been making experiments in this direction for a long time. Recently he has been at work upon a machine of his own invention and a trial of it was made May 6, near Occouvan, Va., in the presence of Prof. Alex. Graham Bell. The New York Sun of May 14 publishes the following account of the trial as given out by Professor Bell and endorsed by Professor Langley:

"The aerodrome, or 'flying machine,' in question was of steel, driven by a steam engine. It resembled an enormous bird, soaring in the air with extreme regularity in large curves, sweeping steadily upward in a spiral path, the spirals with a diameter of perhaps 100 yards, until it reached a height of about 100 feet in the air, at the end of a course of about half a mile, when the steam gave out, the propellers which moved it stopped, and then, to my further surprise, the whole, instead of tumbling down, settled as slowly and gracefully as it is possible for any bird to do, touched the water without damage, and was immediately picked out and ready to be tried again.

"A second trial was like the first except that the machine went in a different direction, moving in one continuous gentle ascent as it swung around in circles like a great soaring bird. At one time it seemed to be in danger, as its course carried it over a neighboring wooded promontory, but apprehension was immediately allayed, as it passed 25 or 30 feet above the tops of the highest trees there, and, ascending still further, its steam finally gave out again, and it settled into the waters of the river not quite a quarter of a mile from the point at which it arose. No one could have witnessed these experiments without being convinced that the practicability of mechanical flight had been demonstrated."

Professor Langley also made public a supplemental statement, giving some important data regarding experiments. He said: "The aerodrome or flying machine has no gas to lift it, as in the case of a balloon, but, on the contrary, it is about one thousand times heavier, bulk for bulk, than the air on which it is made to run, and which sustains it somewhat in the way in which thin ice supports a swift skater. The power is derived from a steam engine, through the means of propellers, but, owing to the scale on which the actual aerodrome is built, there has been no condensing apparatus to use the water over and over. Enough can be carried for only a very brief flight, a difficulty which does not belong to larger machines than the present example, in which the supporting surfaces are but about fourteen feet from tip to tip. The distance flown each time was about one-half mile. The rate of speed depends (as in the case of any vehicle on land) on whether it is going on a level or up hill. In the case of this last trial of May 6 the machine was ascending, that is to say it was going up hill all the time, and went through a distance of one-half mile or more in one and one-half minutes, or at the rate of a little more than twenty miles an hour."

Personal.

Mr. A. S. Dunham, General Manager of the Ohio Southern road, has resigned.

Mr. H. A. V. Post, of New York, has been chosen President of the Chattanooga Southern.

Mr. H. W. Matters, Purchasing Agent of the Louisville, Evansville & St. Louis, has resigned.

Mr. E. P. Huston, Joint Receiver with Mr. E. O. Hopkins, of the Peoria, Decatur & Evansville, has resigned.

W. A. Meagher has been appointed Master Mechanic of the Gulf & Interstate, with office at Galveston, Tex.

Mr. Charles E. Levy, of New Orleans, La., has been chosen President of the New Orleans & Western Railroad.

Mr. O. Emerson Smith, of Portsmouth, Va., has been appointed Receiver of the Norfolk & Virginia Beach Railroad.

Mr. Walter Layman has been appointed Master Mechanic of the Ohio River Railroad, vice A. L. Courtrite resigned.

Mr. Aldace F. Walker has resigned as Receiver of the St. Louis & San Francisco, and Mr. J. J. McCook is now sole Receiver.

Mr. A. J. Beltz has resigned the position of Master Mechanic of the Delaware, Susquehanna & Schuylkill Railroad at Drifton, Pa.

Mr. Joseph Dickson has been appointed Receiver of the Litchfield, Carrollton & Western, in place of Mr. C. H. Bosworth, resigned.

Mr. F. E. House has been appointed Chief Engineer of the Butler & Pittsburgh road, the new line to be constructed by Carnegie interests.

Mr. F. W. Huidekoper, of New York, has been elected President of the Chicago, Peoria & St. Louis road, in place of Mr. Henry W. Putnam, Jr.

Mr. H. H. Swift has been appointed General Car Foreman of the Cincinnati, Hamilton & Dayton Railroad, with headquarters at Lima, O.

Mr. Charles H. Grundy has been appointed General Manager of the Marshfield & Southeastern, with office at Marshfield, Wis., vice A. A. Hopkins.

Mr. J. H. Hill has been appointed General Manager of the Galveston, Houston & Henderson, taking effect May 15, with headquarters at Galveston, Tex.

J. H. Reed has resigned the Vice-Presidency of the Pittsburgh & Lake Erie Railroad Company, to identify himself with the Carnegie railroad interests.

Mr. E. D. Bronner, Master Car Builder of the Michigan Central, has been appointed Assistant Superintendent of Motive Power of that road, with headquarters at Detroit, Mich.

Mr. George T. Jarvis, who has been recently appointed Receiver of the Louisville, Evansville & St. Louis Consolidated road, will also act as General Manager of the company.

Mr. M. F. Bonzano, late General Superintendent of the South Jersey, has accepted the position of General Manager of the Chattanooga Southern, with headquarters at Chattanooga, Tenn.

Mr. W. Cockfield has resigned the position of Locomotive and Car Superintendent of the Inter-oceanic Railway and has been appointed Master Mechanic of the Mexican Central, at San Luis.

Mr. C. H. Doebler, formerly Master Mechanic of the Big Four at Wabash, Ind., has been appointed Master Mechanic of the Eastern division of the Wabash Railroad, with headquarters at Fort Wayne, Ind.

Mr. Frank J. Zerbee has been appointed Master Mechanic of the Michigan division of the Cleveland, Cincinnati, Chicago &

St. Louis, with headquarters at Wabash, Ind., to succeed Mr. C. H. Doebler, resigned.

Mr. W. J. Karner has resigned as General Manager of the St. Louis, Belleville & Southern road and the Crown Coal and Tow Line, which are now controlled by the Illinois Central, and the office has been abolished.

Mr. J. Layng has been elected Second Vice-President of the West Shore road, in addition to the office of General Manager, which he has held for several years. He is also the second Vice-President of the Big Four.

Mr. W. R. McKeen, Jr., has been appointed General Foreman of the locomotive department of the Vandalia line, with headquarters at Terre Haute. He retains his position of General Foreman of the car department.

Mr. Thomas Trezise, Master Mechanic of the Philadelphia division of the Baltimore & Ohio, has been transferred to the Pittsburgh division, with headquarters at Pittsburgh. Mr. E. T. White succeeds him at Philadelphia.

Mr. George W. N. Reed, formerly Treasurer of the Pratt & Whitney Company, of Chicago, has been elected Vice-President and General Manager of the company. He has been succeeded as Treasurer by Mr. J. C. Stirling.

Mr. C. J. Clifford has been appointed Superintendent of Motive Power of the Chicago, Lake Shore & Eastern Railway Company. Mr. E. B. Smith is appointed Master Car Builder, reporting to Superintendent of Motive Power.

Mr. I. N. Kalbaugh, Master Mechanic of the Baltimore & Ohio at Glenwood, Pa., has been appointed Division Superintendent of Motive Power of that road, with headquarters at Baltimore, Md., to succeed Mr. A. J. Cromwell, resigned.

Mr. G. W. Dickenson has been appointed General Manager of the Northern Pacific, with headquarters at Tacoma, Wash. Mr. W. L. Darling has been appointed Chief Engineer, with headquarters at St. Paul, vice E. H. McHenry.

Mr. W. A. Bell, foreman of the shops of the Cleveland, Cincinnati, Chicago & St. Louis, at Dillon street, Indianapolis, Ind., has been appointed Master Mechanic of the Louisville division of that road, with headquarters at Louisville, Ky.

Mr. T. J. Hennessy, formerly Traveling Engineer of the Michigan Central, has been appointed Division Master Mechanic of that road, with headquarters at Jackson, Mich. Mr. Peter Miller, Acting Master Mechanic, has been made Master Mechanic.

Mr. E. S. Washburn, Vice-President of the Kansas City, Fort Scott & Memphis, was on May 12 chosen President of the Kansas City Belt Railway and the Kansas City Union Depot Company, positions made vacant by the decease of Mr. George H. Nettleton.

Mr. H. G. Frazer, Auditor and Purchasing Agent, and Mr. E. Fairfax, Treasurer, of the Knoxville, Cumberland Gap & Louisville, have retired from their respective positions on account of the sale of the road to the Southern Railway, and the offices have been abolished.

Mr. E. V. Sedgwick, formerly Master Mechanic of the Mexican Central, and for a short time Locomotive and Car Superintendent of the Intercoastal Railway, has been appointed Superintendent of Motive Power and Superintendent of Transportation of the latter road.

Mr. William H. Schoen, of the Schoen Manufacturing Company, and a brother of the President of that company, died on May 18, aged 54 years. Mr. Schoen became associated with the company at the time of its organization and remained with it up to his death.

Mr. P. M. Hammett has been appointed Division Master Mechanic of the Boston & Maine, at Boston, vice Mr. A. B. Barrett. Mr. D. A. Smith has been appointed Master Mechanic of the Eastern, Western and Northern divisions, with headquarters at Somerville, Mass.

Mr. Bernard Vogle has been appointed Mechanical Engineer of the Delaware & Hudson Canal Company, with office at Green Island, N. Y. Mr. Vogle has been with this road for nearly ten years as Chief Draftsman, and has practically occupied the position of Mechanical Engineer for the past three or four years.

Owing to his protracted illness, the Directors of the Pennsylvania Railroad have granted General Superintendent Mr. F. L. Sheppard an indefinite leave of absence, and appointed Mr. J. M. Wallis, at present Superintendent of Motive Power on the division, Acting General Superintendent during Mr. Sheppard's disability.

Mr. Adolph Buize has been appointed General Purchasing Agent for the Grand Trunk road. At one time he was Purchasing Agent of the Missouri Pacific, but recently he has been in the railroad supply business at St. Louis. The Grand Trunk heretofore has not had a Purchasing Agent, the department being in charge of the General Storekeeper.

Mr. J. T. Odell has resigned as Second Vice-President and General Manager of the New England Railroad to accept the presidency of the Butler & Pittsburgh, projected from Butler to Pittsburgh, Pa. His headquarters will be at the latter place. Mr. Odell was Vice-President and General Manager of the New York & New England and its successor, the New England, since 1893, previous to which date he was for four and one-half years General Manager of the Baltimore & Ohio.

Mr. William S. Sloan, Second Vice-President of the Delaware, Lackawanna & Western Railroad, died May 12, of paralysis, at South Wilton, Conn., where he has been undergoing treatment for nervous prostration for some time. Mr. Sloan was the son of the President of the Delaware, Lackawanna & Western. He was born in Brooklyn in 1859, and was graduated from Columbia in 1882. He entered the service of the Delaware, Lackawanna & Western Railroad and rose to the position of Second Vice-President. He was Vice-President of the Fort Wayne & Jackson Railroad, a director in the Bank of the State of New York, a member of the Executive Committee of the American Tract Society, treasurer of the South Dutch Reformed Church and secretary of the Columbia College Alumni Association. Mr. Sloan was of a quiet and studious nature and greatly interested in the work of the Y. M. C. A., having been one of the heads of that association in this country. Mrs. Sloan and five children survive him.

Col. Frank K. Hain.

No event which has occurred for a long time has caused so much pain and produced such a shock to those who knew him, as the tragic death of Colonel Hain, which occurred at Clifton Springs, N. Y., on May 9. He had been suffering from nervous prostration for several months and had gone to a sanitarium for rest and medical treatment. On the afternoon of the 9th he left the institution and walked down to view the railroad station. Soon after he was discovered under a moving train, some of the cars of which had passed over him. When taken out he was still living, but died before medical aid reached him. The accident was not seen by any one and it is not known how it occurred. For the following particulars relating to his life and career we are indebted to the New York Herald:

"Colonel Frank K. Hain was born in Berks County, Pennsylvania, about fifty years ago, and commenced his railway career in early youth as an apprentice in the machine shop of the Philadelphia & Reading Railroad. Here, by constant attention and unwearied application, he early in life fitted himself for the eminent position he afterward occupied among American engineers.

"At the end of his apprenticeship he entered the United States Navy at the age of twenty-one as an engineer, serving for two years, and participating in some of the most memorable naval engagements of the late war. Among these were the capture of Forts Jackson and St. Philip and the city of New Orleans by the fleet under Admiral Farragut.

"Withdrawing from the navy he entered into still more active service in the army, in which he won reputation as a brave and

gallant officer. At the close of the war he obtained employment as a draughtsman with the Delaware, Lackawanna & Western Railroad Company at Scranton, after which he entered the service of the Pennsylvania Railroad Company at Altoona. Here his abilities as an executive officer were soon acknowledged, and he was promoted to be Superintendent of Motive Power for the Philadelphia & Erie Division of the road.

"From this position he withdrew to accept charge of the designing department of the great Baldwin Locomotive Works, of Philadelphia. In 1871 he visited Russia in the interest of the firm and spent some 15 months in introducing and putting into operation 30 anthracite coal-burning locomotives which he had previously designed.

"Colonel Hain was offered the position of Superintendent of Motive Power on the Erie Railroad two years later, which he accepted. He afterward became General Superintendent of the Keokuk & Des Moines Railroad, maintaining his position after the road became merged into the Chicago, Rock Island & Pacific system.

"Colonel Hain was best known to the New York public through his connection with the elevated railroads of this city. When the New York and the Metropolitan Elevated Railroad lines were leased to the Manhattan Company it was found that a competent man was needed as General Manager or Superintendent. Russell Sage and the late Jay Gould recommended to the Board of Directors that Colonel Hain be appointed to the position."

It is not easy, in a brief summary like this, to do justice to the life and character of a man like Colonel Hain, as he was generally known among his friends. He was a man of indefatigable industry and energy, and perhaps in the position which he occupied his greatest deficiency was his inability to lay responsibilities on other shoulders, instead of assuming them himself. The remarkable record of the road which he managed for so many years, which has carried many millions of passengers during that period, with almost complete immunity from accident, excepting through the fault or carelessness of those who were injured, shows how ably and conscientiously every department was supervised. By day and by night, in sunshine, fog and storm, the responsibility for the operation of this road was borne by Colonel Hain, with little relaxation and no complete relief. More than a year ago there were signs of physical failure, but against the advice of friends, he continued in the harness. A few months ago work was no longer possible, and he received leave of absence and went, it was reported, South, for rest and recuperation. The few weeks before his death were spent at Clifton Springs.

To those who were not intimately acquainted with him he was reserved and reticent, but, once in his confidence, he was a genial companion and warm-hearted friend. He was deeply interested in his occupation, and faithful and loyal to those who employed him—much more so than they were and are to the public, which they ought to serve better than they do. In his domestic relations Colonel Hain's life was very happy. His wife was a true helpmeet to him, and guarded him in every way possible from the cares and annoyances incident to his occupation. To those who were privileged to enjoy the friendly and confidential talks with him in his own household they will always be a memory to be cherished as long as life lasts. To some who survive him his life and death may serve as a warning, by others it will be tenderly remembered, and to all he may be an example of faithfulness and loyalty to duty.

The Passenger Department of the New York Central road has just issued a new summer folder, entitled "America's Great Resorts." It is number three of the "Four Track Series" of folders, and is replete with information of a practical kind. All the leading resorts, both east and west, are mentioned in it, and the rates and time from New York and from Niagara Falls approximately given. This information will be found valuable to those who contemplate a summer trip, in arranging the details of their journey. The folder is handsomely illustrated and contains a large and accurate map. A copy of the folder can be obtained by sending four cents in stamps to Mr. Geo. H. Daniels, General Passenger Agent of the road, New York City.

The *Scientific American* is going to celebrate its fiftieth anniversary on July 25, by issuing a special number, one of the features of which will be a prize essay on the "Progress of Invention During the Past Fifty Years." A premium of \$250 will be paid for the best essay of not more than 2,500 words. The five next best essays will be published later and paid for at regular rates.

Equipment Notes.

The specifications are out for 200 cars for the Chicago Great Western.

The Florida East Coast Railway is in the market for 100 ventilated box cars and 100 flat cars.

The Cold Blast Transportation Company, Kansas City, is in the market for 100 refrigerator cars.

The Georgia & Alabama road is in the market for six locomotives, three passenger and three freight.

H. K. Porter & Company have received an order for a locomotive for the Rockhill Stone Storage Company.

The Parkersburg shops of the Ohio River road have just turned out a private car for Vice-President G. A. Burt.

The Lehigh Valley has ordered 25 freight and 5 passenger locomotives from the Baldwin Locomotive Works.

The Texas & Pacific has contracted with the Mount Vernon Car Manufacturing Company for 300 freight cars.

The Pennsylvania Railroad has received two large wrecking cars from the Industrial Works, of Bay City, Mich.

The Erie road is building an 80,000-lb. coal car which is to be fitted with automatic devices of the Dumping Car Improvement Company.

The Southern Railway has contracted for six freight engines with the Brooks Locomotive Works and four with the Pittsburgh Locomotive Works.

The Pullman Palace Car Company has received an order for 20 passenger cars for the Brooklyn Bridge at \$3,200 each. The cars are to be provided with electric motors.

The Great Northern is receiving 400 ballast cars from the Roger Ballast Car Company. The cars are combination ballast, coal and ore cars with a capacity of 20 cubic yards or 30 tons.

The Munising Railroad has placed orders through J. T. Gardner, Chicago, for 200 flat cars, 100 going to the Barney & Smith Car Company and the other 100 to Haskell & Barker Car Company.

The Chicago, Milwaukee & St. Paul is providing a convenient means of transporting bicycles without damage by putting in its baggage cars overhead rods carrying rubber-covered hooks on which they can be hung.

The Baltimore & Ohio has contracted with the Safety Car Heating and Lighting Company for the equipment of 200 passenger cars with the Pintsch light. Pintsch gas plants will be erected at Baltimore, Washington and Pittsburgh.

According to the statement of the receivers to the court, the new cars for the Philadelphia & Reading recently ordered were contracted for at the rate of \$575.83 for each coal car; box cars, \$607.83; gondola cars, \$475.82; refrigerator cars, \$892.83.

A law has been passed requiring the Manhattan Elevated to light its passenger cars by gas or electricity. It requires 40 per cent. of the company's cars to be so equipped within one year, 40 per cent. more within two years and all of the equipment within three years.

The ten switch engines built for the Chicago & Northwestern Railway by the Schenectady Locomotive Works are equipped with Latrobe open hearth steel tires, Midvale steel connecting rods, Nathan lubricators and injectors, five with American and five with Richardson balance valve, Ashcroft gages and Ashton pop safety valve. The boilers are made of carbon steel and covered with the "sail mountain" asbestos covering, mentioned in our May issue, of which Bruner, Sprague & Company, of Chicago, are the agents.

Contracts for the 5,000 new freight cars for the Baltimore & Ohio Railroad were given out early in the month as follows: South Baltimore Car Works, 1,000; Pullman Palace Car Company,

1,000; Missouri Car and Foundry Company, 900; Michigan-Peninsula Car Company, 800; Barney & Smith Car Company, 800, and Mount Vernon Car Company, 500. Of this order 1,800 are single-hopper cars, 1,800 box cars, 1,000 coke cars and 400 double-hopper coal cars. It is stated that the Buckeye coupler and the Schoen pressed steel bolster will be used on all of these cars, the Chicago roof on the box cars, and that the order for springs has been divided among the Pickering Spring Company, the A. French Spring Company and the Chas. Scott Spring Company. The Davis box lid, manufactured by the Davis Pressed Steel Company of Wilmington, Del., will be used on a large part of this equipment.

New Locomotives.

The New York, New Haven & Hartford Railroad Company has recently placed an order with the Schenectady Locomotive Works for 20 heavy passenger locomotives. They are to be of the American type with 20 by 24-inch cylinders and 73-inch driving wheels with steel centers. The engines will weigh about 134,000 pounds. The boilers are to be 62 inches diameter in the smallest ring, with 312 2-inch tubes 12 feet long. The firebox will be of the "toboggan" type placed on top of the frames and will be 9 feet long and 41 inches wide. The boilers are to have an extended wagon top with radial stays, the dome being on the extension of the wagon top. The maximum travel of valves is to be 6 inches. The guides are to be of the crocodile form, that is, one bar above and the other below the cross-head. The boilers are made very heavy, with butt longitudinal joints, sextuple rivetted. The specifications were prepared by Mr. John Henney, Jr., Superintendent of Motive Power of the line. The engines will be the most powerful of their class which have thus far been built.

The Schenectady Company are also completing five Mogul freight engines for the Maine Central road. These will have 20 by 26-inch cylinders and 63-inch wheels.

Mr. Harvey Middleton, the new Superintendent of Machinery of the Baltimore & Ohio Railroad, has prepared specifications for some new heavy ten-wheeled passenger engines for that line. They are to have 21 by 26-inch cylinders and 78-inch driving wheels, and will weigh about 140,000 pounds. Owing to the short curves on this line the total wheel base of these engines will be only 24 feet 6 inches and the driving wheel base 13 feet 8 inches. The trailing driving axle is under the middle of the firebox, and the other wheels are placed as near together as their diameters will permit. The firebox is also of the "toboggan" type, placed on top of the frames and with an extended wagon top and radial stays.

Trade Catalogues.

In 1891 the Master Car-Builders' Association, for convenience in the filing and preservation of pamphlets, catalogues, specifications, etc., adopted a number of standard sizes. These are given here in order that the size of the publications of this kind, which are noticed under this head, may be compared with the standards, and it may be known whether they conform thereto.

It seems very desirable that all trade catalogues published should conform to the standard sizes adopted by the Master Car-Builders' Association, and therefore in noticing catalogues hereafter it will be stated in brackets whether they are or are not of one of the standard sizes.]

STANDARDS.

For postal-card circulars..... 3 3/4 inches by 6 1/4 inches.
(3 3/4 inches by 6 inches.)
Pamphlets and trade catalogues..... 6 inches by 9 inches.
(9 inches by 12 inches.)
Specifications and letter-paper..... 8 1/4 inches by 10 3/4 inches.

ILLUSTRATED PRICE LIST OF ARCHITECTS, ENGINEERS AND DRAFTSMEN'S SUPPLIES. F. Weber & Co., Philadelphia. 259 pages, 6 by 9 inches. (Standard size.)

This is an elaborate catalogue, which gives a great deal of detailed information about the materials and instruments used by architects, engineers and draftsmen, and sold by this firm, but it does not seem to call for special comment.

CATALOGUE OF PEDRICK & AYER COMPANY, Manufacturers of Special Railroad Machine Tools. Philadelphia. 105 pages. 6 by 9 inches. (Standard size.)

The tools manufactured by this company include Richard's patent open-side planer, which is made in a number of sizes.

Full descriptions are given of this machine and also illustrations showing the kind of work which can be done on them and the method of doing it.

The list of tools of this company also includes shapers, plate-scarfing or planing machine, specially constructed for scarfing steel ship plates, nutting machines, five forms and sizes of which and various attachments for them are described and illustrated. These attachments include universal index-heads, vertical index-heads, vertical or angular attachments, vises for holding work, vise chucks, circular attachments, etc. Following these are a series of illustrations showing how work can be done on these machines with direction for doing it. Among the other tools which are made by this company, and are illustrated in this publication, are universal grinding machines, portable valve-seat rotary planing machine, chucks for holding valves while they are being planed, portable crank-pin and wrist-pin turning machines, horizontal boring and drilling machines, cylinder boring and facing machines, portable cylinder boring machine, and various tools, chucks and other devices, to be applied to the machines which the company makes.

Another apparatus is intended for heating, setting and removing tires. "It consists of an oil tank and a furnace, the latter having over the fire grate four retorts; the first three of them for making gas, and the fourth for heating the compressed air. The three gas cylinders are connected together so that the gas in its passage from the first retort, where the oil is admitted, becomes very hot. The fourth cylinder, being in the hottest place, heats the air to about the same temperature." The oil is thus converted into gas and is burned in contact with the tires, being mixed with air in the burners.

Other machines which the company makes are Otto's patent flue cleaner, a jointer for facing brasses of connecting rods, a locomotive lath motion model, etc.

A new department, which has been added to the establishment, is that for making air compressors, pneumatic hoists and appliances used in connection with this class of machinery; the extensive use of which has made it an important branch of the business. Special attention is now given to this department and various new appliances have been brought out.

The catalogue is illustrated by excellent wood cuts, is well printed and has a good index, all of which can be commended.

The Jungfrau Railway.

Competitive plans are desired by the Bureau der Jungfraubahn, Bahnhofstrasse 10, Zürich, for the proposed railway to the summit of the Jungfrau. The sum set apart for the purpose of making awards to the successful competitors is about \$6,000. The prizes in question are offered for the best solution of three different groups of problems. The first of these relates to the construction of the line, and plans are desired showing the tunnel profile; the lining, if any, the kind of permanent way and superstructure proposed; the racks, points and switches. The question of electrical power transmission from the falls on the Lutschine River is also included in the first group, together with the designs for the cars, stations, club buildings and elevator from the last station to the mountain summit. The lift of the elevator is fixed at 328 feet, and the shaft is to be 26 feet in diameter, and to be provided with stairways. In the second group of problems proposals are required for methods of executing the work, the driving of the tunnels, removal of spoil, and of precautions for the safety of the men. The third group is concerned with the working of the line, and competitors should deal with the question of maintenance of the way, the electric lighting of the tunnel, cars and stations, and with heating of the two latter by the same agent. Finally, the security of the passengers and staff should also be considered in this connection. Such plans as are sent in will be considered by experts, on whose recommendations the premiums will be awarded. Successful competitors will have no further claim on the committee, as the prize is considered to be considered as payment in full for the use of the premium designs. Unsuccessful designs will be restored to their originators and will remain their private property.

The maximum gradient of the proposed line is fixed at 1 in 4, and the minimum radius of curvature at 328 feet. The maximum width of the cars must not exceed 8.2 feet, and the greatest height

9.84 feet. The speed has been fixed at from 4.3 to 6.2 miles per hour. The water power available is 5,000 horse power effective. The falls are situated at about five miles from the proposed starting point of the line, which will be about 1.5 miles from the tunnel portal. The total length of tunnel will be about 6.2 miles. The latest date for sending in proposals is August 1 next.—*Iron Age*.

The Steam Boiler Plant of the National Electrical Exposition.

The Improved Root Water Tube Boiler, manufactured by the Abendroth & Root Manufacturing Company, of New York, was selected to furnish all the steam used at the National Electrical Exposition, now open in New York, there being two equal units forming one battery of 500 horse power of boilers. The well-known anthracite automatic stoker, manufactured by the Wilkinson Manufacturing Company, of Bridgeport (Montgomery County), Pa., was selected to handle the coal supplied to the fire.

The coal, after being dumped at some distance from the boilers, in the rear, is taken by the C. W. Hunt coal conveyor and carried along the side and a little past the front of the boilers where it is elevated to a point near the ceiling from whence it is delivered through tubes to the hoppers of the Wilkinson Stokers, and, of course, from that point it is fed uniformly down the inclined grates, burning on its way and reaching the foot of the grates as ash, and finally it is dumped into the ash pit below.

The Hunt conveyor next takes the ash and carries it back to a dumping place some distance in the rear of the boiler, dumping it there automatically.

The water of New York City being especially well adapted for boiler use, no filters or purifiers were considered necessary. The pump supplying feed water to the boilers is one of the H. R. Worthington Company's make, and is electrically driven by one of Crocker-Wheeler Company's pump motors: The pump is one of the "steeple pattern," and combined with its motor presents a novel and elegant appearance.

Two of the Root feed-water regulating devices, manufactured by the Abendroth & Root Manufacturing Company, of New York, work in connection with the boilers and feed pump, starting the pump automatically when the water level in the boiler falls below its proper level, and again stopping the pump when the water in the boiler tends to rise above its normal working level.

Thus the entire working of the boiler is made automatic, even to the damper regulation, which is effected by the mechanism made by the Locks Damper Regulator Company, of Salem, Mass.

The entire operation of this plant is so safe and simple that it was decided to put it in charge of a woman to show conclusively that if steam-users will put in the best of everything that the market places at their disposal, and if they will equip their plant properly throughout, it will become so simple in its operation that a woman can operate it as well as the most expert fireman.

The valves used in the main steam piping are especially adapted to high-pressure and ordinary rough handling. They are heavy, straight way valves with an outside yoke and screw and are made by the Chapman Valve Manufacturing Company, of Indian Orchard, Mass.

The pressure carried by the boilers is 125 pounds. This pressure is carried along the main steam piping to a point just beyond the first engine and there it is reduced by a reducing valve to 90 pounds, at which pressure it is carried to all the other engines on exhibition.

At the exhibit of the Ashcroft Manufacturing Company two Edison recording gages will be found in operation, one recording the pressure of steam at the boiler and the other gage recording the pressure on the low pressure side of the reduction valve.

The boilers are equipped with steam gages manufactured by the Ashcroft Manufacturing Company, and with nickel seated pop safety valves made by the Consolidated Valve Company, both of New York and Bridgeport, Conn.

The fine smooth black finish of the boilers is produced by the use of Dixon's Graphite Boiler Front Paint made by the Joseph Dixon Crucible Company, of Jersey City, N. J., whose exhibit will be found in the neighborhood of the boilers. The mason work is certainly of exceptionally fine appearance and is most creditable to the mason, Garret S. Wright, of New York.

The exhaust piping from the 11 engines will probably interest many of the visitors to the Exposition as it has been used by so many electric light companies for this purpose. We refer to the spiral riveted pipe made by the Abendroth & Root Manufacturing Company, of New York.

The battery of improved Root boilers use at this exposition is in-

exact duplicate to the twelve batteries of boilers used at the celebrated tunnel plant of the Baltimore & Ohio Railroad in Baltimore, Md.

The engines on exhibition are all direct connected with generators with two exceptions.

The engines will be found arranged in the following order, beginning with engine nearest to boilers:

- The Phoenix engine (the only compound engine).
- The Ball & Wood engine.
- The Straight Line engine.
- The Harriabugh engine.
- The Watertown engine.
- The Payne engine.
- The McEwen engine.
- The Weston engine (belted).
- The New York Safety engine (belted).
- The Case engine.
- The Shepard engine.
- The Woodbury Engine.

The exhaust from all of these engines is passed through a Goubert feed-water heater and then sent through the spiral riveted exhaust pipe (placed outside the building) to a point above roof.

All the feed water used will pass through this heater, thus supplying the boilers with a bountiful supply of water heated to near 212 degrees.

Part of the steam pipe covering work is Keasbey & Matteson's magnesia sectional covering, while the other is Gilmour's asbestos covering.

Cast-Iron Wheels in Europe.

Of all the European countries Austria is the only one where the use of cast-iron wheels for railroad purposes is not now prohibited by law, and where, consequently, their manufacture has not been entirely killed. Those laws originated at a time when the make-up of such wheels was far from the present state of perfection as manufactured in the United States.

The general use of these wheels in the United States gave to the manufacturers an opportunity of improving their methods, and to furnish better ones, so that the manufacture of cast iron wheels is to-day a large industry in the United States, and it is said there are more cast-iron wheels manufactured in the United States in one day than in all Europe in one year.

That cast-iron wheels are, nevertheless, well liked wherever they are used is proven by the fact that the Austrian Government, during the past year, asked its representative in the United States, Mr. Fr. von Emperger, Consulting Engineer, 71 Broadway, New York, to make an investigation of the American practice. As a result of this investigation the Austrian Government railways placed an order with a prominent car wheel maker for 120 car wheels of the standard size, for the purpose of using them on freight cars with brakes. The lot has been delivered, but cannot be used elsewhere than within the Austrian boundaries. The reason of this limitation is a rule of the German Railway Union Code, which comprises all central Europe, or at least all the States neighboring Austria. This rule prohibits the use of brakes with cast-iron wheels, and the interchange of cars with cast-iron wheels is therefore impossible, except within the Austrian boundaries, where the railway system comprises some 6,000 miles.

If, by these trials, the European officials can be induced to abolish the above-mentioned rule of the German Railway Union Code there would be a bright prospect for the export of cast-iron wheels to Europe, as the necessary experience and skilled labor, as well as the requisite machinery, cannot be had anywhere in Europe. This trade is, of course, limited to Austria for the present, so far as railways are concerned, and to street railway equipment.

The Bushnell Car Seats.

The eight new passenger cars for the Lehigh Valley's new train between New York and Buffalo, known as the "Black Diamond Express," are all equipped with seats made by the Bushnell Manufacturing Company, of Easton, Pa. The two trains for this service are among the finest ever equipped, and these seats were selected for their beauty and excellence from the samples submitted to the company by competing concerns. They are finished with specially designed mahogany arm rests, and are upholstered in mahogany colored frieze plush.

Since Jan. 1 the Bushnell Manufacturing Company has secured many large and important contracts on both street and steam railways, among which may be mentioned seats for 20 sleepers built by

the Wagner Palace Car Company; 20 cars for Detroit Street Railway Company; 10 cars for Akron, Bedford & Cleveland Railway Company; 18 cars for Cleveland, Painesville & Eastern Railway; 20 cars for Milwaukee Street Railway; 8 cars for Lehigh Valley Railroad; 38 cars for Metropolitan Street Railway of Kansas City; 10 cars for Delaware, Lackawanna & Western Railroad; 15 cars for Philadelphia & Reading Railroad, and 30 cars for Broadway Cable Railway, of New York.

The success which these orders indicate is the result of excellence of design in their output, coupled with the high-grade materials employed.

The New York office of the Otis Steel Company has been removed to the Manhattan Life Building, No. 66 Broadway.

Fox Solid Pressed Steel Company have removed their general offices to rooms 1405, 1407 and 1409, in the Fisher Building, 231 Dearborn street, corner of Van Buren street, Chicago.

Mr. James McLaughlin, recently with the Philadelphia Engineering Works, Limited, has been elected Secretary and Treasurer of the Barr Pumping Engine Company, Philadelphia. Mr. W. W. Lindsay is the General Manager of the latter company.

The Diamond Machine Company, of Providence, R. I., are shipping to the Japanese Government a large order for grinding machinery received through their London house. The shipment comprises a large number of articles, including, among others, ten of their large size water-tool grinders.

Carbon Steel Company, manufacturers of acid open-hearth steel, locomotive firebox and boiler plates, and universal plates for bridge and building purposes, announce the removal of their Chicago offices to rooms 1411 and 1413, in the Fisher Building, 231 Dearborn street, corner of Van Buren street.

The Westinghouse Air-Brake Company intend putting a roof over the open space between their foundry and blacksmith shop buildings at Wilmerding. This will give them additional foundry room to the extent of 50 by 500 feet, in which they will erect another system of flask carriers, thereby increasing the output of their foundry from 30 to 40 per cent.

The Continental Iron Works, Brooklyn, N. Y., have supplied four Morison suspension furnaces to the Tuttle Manufacturing and Supply Company, of Anaconda, Mont., three to the International Navigation Company, of New York, for the steamer *Illinois*, and six to Wm. B. Pollock and Company, Youngstown, O. Also several to the Plant Steamship Company, for use on their steamers.

The Franklin Institute, of Philadelphia, after carefully examining into the merits of Cleveland Twist Drill Company's grip sockets, have awarded the firm the Edward Longstreth medal of merit. This action on the part of the Franklin Institute endorses the company's statements, that this grip socket is the best device for holding and driving taper-shank twist drills that has ever been introduced.

The Geometric Drill Company, of New Haven, Conn., has removed to their new factory at 150 Ashman street. The management is in the hands of W. J. Smith, as heretofore. H. E. Adt, who has been connected with John Adt & Son for 15 years, has become associated with the Geometric Drill Company, and will be in charge of the business department. He will also assist in the designing of special machinery.

Judge Dallas, of the United States Circuit Court for the Eastern District of Pennsylvania, filed an opinion on the 6th ult. granting the Ewart Manufacturing Company a preliminary injunction against James H. Mitchell, restraining the latter from the manufacture of an infringement of the plaintiff company's patented chain, which is known as the "Dodge Chain," and which is legally manufactured by the Link-Belt Engineering Company, of Philadelphia, and the Link-Belt Machinery Company, of Chicago.

Mr. E. P. Roberts, Consulting Engineer, and President of the Correspondence School of Technology, Cleveland, O., has been appointed Consulting Engineer for the Port Clinton, O., Electric Light and Power Company. He is also engineer for the Massillon State Insane Asylum, Massillon, O., having charge of the electrical, heating, hydraulic and sanitary work, the latter two departments being taken care of by Mr. E. C. Cooke. Mr. Roberts is also Consulting Engineer for the Columbus State Hospital. All these are new plants on which bids will be called for within the next 30 days.

The U. S. Standard Drawn Steel Company has been incorporated in Ohio, with a capital stock of \$30,000, and will manufacture stay bolts and hollow and solid shafting, also weldless tubing of brass, copper, iron and steel, solid cold drawn shapes in steel, and solid and hollow billets. The officers are: President, Samuel A. Sague; Vice-President, L. E. James; Secretary, C. E. Westhafer; Treasurer, C. H. Howland. The works will be located at Cuyahago Falls, O., and the general office in the Western Reserve Building, Cleveland, O. Hydraulic machinery will be used to a large extent in the new plant.

The Erie Railroad Company, after careful investigation, and the consideration of a number of plans, have contracted with the Dodge Coal Storage Company, of Philadelphia, Pa., for a 150,000-ton storage plant at East Buffalo, N. Y. The coal will be stocked in nine divisions or piles, each of about 17,000 tons capacity. The plant will be constructed under the patents of the well-known Dodge system, with the latest improvements, including a complete haulage system for handling the cars. The efficiency of the Dodge system is indicated by the fact that every railroad using it has contracted for a second plant, after more or less extended experience with the first.

Mr. T. F. DeGarmo has been appointed Eastern Representative of the Chicago Pneumatic Tool Company, with office in New York; and William Mack, as Western Representative, with office in Denver, Colo. The company are shipping to Europe three hundred (300) machines of their largest size, and are arranging to open a branch office in London. They have added to their line the Manning Sand-papering Machine, which is meeting with great success, and has proven a great labor saver on coach work; a pneumatic car cleaner for cleaning upholstered seats and carpets in the car and sending the dust through a hose out of the window; and the Manning piston air drill, which is an entirely new machine on the market.

At a meeting of the New York and Brooklyn Bridge trustees, on May 20, the Babcock & Wilcox Boiler Company was awarded a contract for two 400 horse-power boilers for \$1,350. The Walker Manufacturing Company, of Cleveland, O., got the contract for two generators of 400 kilowatts, each at \$15,849. The Southworth Foundry and Machine Company, of Philadelphia, received the contract for two 600 horse-power engines at \$16,400. Twenty passenger cars, 48 feet long, and provided with electric motors, were ordered of the Pullman Palace Car Company, at \$3,200 each. The trustees authorized Chief Engineer Martin to advertise for bids for an extension of the power house adequate to receive the additional machinery. This machinery ordered is for the electrical equipment for switching trains at the terminals.

Bids for the machinery and electrical equipment for the new Bascule bridge at N. Halsted street, Chicago, were opened on May 11. The machinery bids were as follows: Vulcan Iron Works, Chicago, \$12,956; Chas. Kaestner & Co., \$15,845.

The bids for electrical work were as follows: General Electric Company, \$7,000; Geo. P. Nichols & Bro., \$6,272.50; Vulcan Iron Works Company, \$5,379.

The contract for the substructure had previously been let to Wilson & Jackson, Chicago, and for the superstructure to the Klug Bridge Company, Cleveland. This is to be one the finest equipped bridges in the city, and is to be of the same pattern as the Metropolitan Elevated bridge at Jackson street, which is working so successfully.

In a neat little pamphlet issued by the Standard Paint Company, 2 Liberty street, New York, the method of applying "P. & B. Ruberoid" car roofing is described. This material has as a foundation the best felt manufactured, and this is saturated with the "P. & B." water and acid proof composition. It is a perfect non-conductor, is not affected by changes of temperature, is permanently pliable and elastic, is easily applied and is claimed to have as long a life as the car itself. It is put up in rolls 60 inches wide, each roll containing enough to cover a car. The same material has been successfully used in refrigerator cars between the floors. The "P. & B." insulating papers are also used extensively in refrigerator car insulation, the Merchants' Despatch Transportation Company alone having bought over 1,500,000 square feet of it since Jan. 1, 1895. The "P. & B. Ruberoid" roofing for buildings is put up in rolls 36 inches wide, containing 216 square feet and is claimed to outlast metal roofs. Its use is advocated for round houses, train sheds, boiler houses, etc.

The Pedrick & Ayer Company, 1001 Hamilton St., Philadelphia, who manufacture the well known belt driven air compressors, advocate the use of these compressors "in series," which is accomplished by setting the automatic regulating devices on the machines at slightly different pressures, the lowest one being set at the minimum pressure desired. The others are set between this minimum, and the maximum, so that they take up their work in succession and keep at it until the maximum pressure is reached, each one stopping in turn, and remaining idle until more air is required. This is claimed to be a very decided advantage in installing an air plant. One machine can at first be installed, and when the requirements call for more air, another of the same kind can be attached to the main conveying the air to the receiver, and not in any way impairing the utility of the first machine, and this process of adding machines continued as long as the demand for air increases. This plan has the advantage that should any machine become worn and require repairing, that particular machine can be disconnected and not seriously cripple the series. It is urged that even for large plants these belt compressors are economical, as they derive their power from the large shop engine, which is ordinarily more economical than the much smaller steam cylinder of a steam driven air compressor.

Spencer Miller, Engineer of the Cableway Department of the Lidgerwood Manufacturing Company, New York City, has returned from a four months' visit to Europe much improved in health and bringing with him all the American rights under the patents of the Temperly Transporter which the Lidgerwood Company will immediately place upon the market. The Transporter is a hoisting and conveying device employing a suspended beam as a trackway. The chief points in its favor are simplicity in operation, low cost and extreme flexibility. No skill whatever is required to operate the apparatus. About 300 transporters have already been made and the device has therefore passed through its experimental stage. The British Admiralty have adopted it for coaling battleships, having recently purchased nearly 100 of them. Mr. Miller also secured a contract in Paris from the new Panama Canal Company, for seven cableways which were shipped April 30, to Panama. Mr. Miller has recently had a patent granted him for a novel form of scoop bucket, which has been thoroughly tested, and has proved entirely satisfactory in loan and sand. It is employed on a cableway. The bucket is lowered to the toe of the sand bank, and the carriage is run ahead so that the draw of the hoist rope is approximately parallel with the slope of the bank and the bucket is drawn up, thereby filling it. If the material be soft the bucket will fill without guidance, but in harder material the bucket has to be guided by a man following it. The bucket is then conveyed back to the place of dumping, and by virtue of lowering the bucket it is overturned and the load spilled. Mr. Miller has also had another patent granted him for a novel form of aerial dumping device.

Messrs. S. T. Wellman, J. W. Seaver and C. H. Wellman announce that they have associated themselves together under the name of the Wellman, Seaver Engineering Company, with offices in the New England Building, Cleveland, O. They expect to make specialties of the following lines of construction: Bessemer and open hearth steel plants, including the most modern furnaces and rolling mills and special electric, hydraulic and pneumatic machinery for the economical handling of material in and around the works; manufacturing and mill buildings of every description, designed with special reference to economical and substantial construction; coal handling and storage plants.

They are the owners of the Wellman Patent Rolling Open Hearth Steel Melting Furnace, which is now in operation at the works of the Illinois Steel Company, South Chicago, Ill., and at the Standard Steel Works, Burgham, Pa. They also own the Wellman patent method and machine for charging open hearth furnaces, in use at both the above works as well as in the Homestead Steel Works of the Carnegie Steel Company, and the Pencoyd Iron Works, Philadelphia, Pa. They own the exclusive right to manufacture the Seaver Patent Coal Elevator.

Complete plans, specifications, and estimates for work will be furnished in any of these lines and they are prepared to take contracts for the same, erected and in working order, or will furnish the drawings and superintend the construction for parties desiring to do their own work. They will act as Consulting Engineers for steel works desiring their services in that capacity. The well-known metallurgist chemist, Mr. Geo. W. Goetz, of 219 Thirty-Fourth Street, Milwaukee, Wis., is associated with the company.

Our Directory

OF OFFICIAL CHANGES IN MAY.

We note the following changes of officers since our last issue. Information relative to such changes is solicited.

Butler & Pittsburg.—F. E. House has been appointed Chief Engineer.

Boston & Maine.—Mr. P. M. Hammett has been appointed Division Master Mechanic, vice A. B. Barrett, at Boston. Mr. D. A. Smith is appointed Master Mechanic of Eastern, Western and Northern divisions, with headquarters at Somerville.

Baltimore & Ohio.—Mr. I. N. Kalbaugh has been promoted to the position of Division Superintendent of Motive Power, with headquarters at Baltimore, vice A. J. Cromwell, resigned. Master Mechanic Thomas Trezise has been transferred to the Pittsburg division with office at Pittsburg and is succeeded at Philadelphia by E. T. White.

Chicago, Peoria & St. Louis.—Mr. F. W. Huidekoper has been elected President, vice Mr. H. W. Putnam, Jr.

Chicago, Lake Shore & Eastern.—C. J. Clifford is appointed Superintendent of Motive Power, and E. B. Smith Master Car Builder, reporting to Mr. Clifford.

Chattanooga Southern.—Mr. H. A. V. Post, of New York, has been chosen President. Mr. Joseph W. Burke has retired from the position of receiver. Mr. M. F. Bonzano has been appointed General Manager, with headquarters at Chattanooga.

Cleveland, Cincinnati, Chicago & St. Louis.—Mr. W. A. Bell has been appointed Master Mechanic at Louisville, Ky. Mr. F. J. Zerbe has been appointed Master Mechanic at Wabash, Ind., vice C. H. Doebler, resigned.

Delaware, Lackawanna & Western.—Mr. Wm. S. Sloan, Second Vice-President, died on May 11.

Delaware, Susquehanna & Schuylkill.—Mr. A. J. Beltz has resigned as Master Mechanic at Drifton, Pa.

Delaware & Hudson Canal Co.—Mr. Bernard Vogle has been appointed Mechanical Engineer, with office at Green Island, N. Y.

Gulf & Interstate.—W. A. Meagher has been appointed Master Mechanic, with office at Galveston.

Galveston, Houston & Henderson.—Mr. J. H. Hill has been appointed General Manager, with headquarters at Galveston, Tex.

Grand Trunk.—Mr. Adolph Butze has been appointed General Purchasing Agent. Mr. Wm. McWood, formerly Assistant Mechanical Superintendent, has been appointed Superintendent of the Car Department with headquarters at Montreal.

Interoceanic.—Mr. E. V. Sedwick has been appointed Superintendent of Motive Power and Superintendent of Transportation.

Knoxville, Cumberland Gap & Louisville.—Mr. H. G. Fraser, Purchasing Agent, has resigned and the office is abolished.

Kansas City Belt & Kansas City Union.—Mr. E. S. Washburn has been chosen President, to succeed G. H. Nettleton, deceased.

Louisville, Evansville & St. Louis.—Purchasing Agent H. W. Matters has resigned.

Louisville, Evansville & St. Louis Consolidated.—Mr. Geo. T. Jarvis, Receiver, will also act as General Manager.

Litchfield, Carrollton & Western.—Mr. Joseph Dickson has been appointed Receiver, vice C. H. Bosworth, resigned.

Mobile Central.—Mr. W. Cockfield has been appointed Master Mechanic at San Luis.

Marshfield & Southeastern.—Mr. Chas. H. Grundy has been appointed General Manager, with headquarters at Marshfield, Wis.

Michigan Central.—Mr. E. D. Browner, Master Car Builder, has been appointed Assistant Superintendent of Motive Power, with headquarters at Detroit. Mr. J. T. Hennessy has been appointed Division Master Mechanic at Jackson. Peter Miller has been appointed Master Mechanic.

Norfolk & Virginia Beach.—Mr. O. E. Smith has been appointed Receiver.

New Orleans & Western.—Mr. Chas. E. Levy has been chosen President.

New England.—Mr. J. T. Odell has resigned the position of Second Vice-President and General Manager.

Northern Pacific Railroad.—G. W. Dickenson has been appointed General Manager, with headquarters at Tacoma, Wash. Geo. H. Earle is Secretary to Receivers, with office at St. Paul, Minn. W. L. Darling has been appointed Chief Engineer, with office at St. Paul, vice E. H. McHenry.

Ohio Southern.—General Manager A. S. Dunham has resigned.

Ohio River.—Walter Jayman has been appointed Master Mechanic, vice A. L. Courttrite, resigned.

Pennsylvania.—J. M. Wallis, Superintendent of Motive Power, is appointed Acting General Superintendent of Division during disability of Superintendent F. L. Sheppard.

Saginaw, Tuscola & Huron.—Sanford Keeler has resigned as General Manager. The President, William L. Webber, assumes the title of that office.

St. Louis, Belleville & Southern.—Mr. W. J. Karner, General Manager, has resigned, and the position is abolished.

St. Louis & San Francisco.—Mr. Aldace F. Walker has resigned as Receiver and Mr. John J. McCook is now sole Receiver.

Wabash.—C. H. Doebler is appointed Master Mechanic at Fort Wayne, Ind.

West Shore.—Mr. J. D. Layng, General Manager, has also been made Second Vice-President.

Employment.

A young man desirous of advancing, is open for engagement as Purchasing Agent or General Storekeeper, has had about six years experience as general storekeeper, also several years experience with Mechanical Department accounts. He is strictly sober, can furnish A1 references. Address STOREKEEPER, care AMERICAN ENGINEER AND CAR BUILDER.

AMERICAN ENGINEER CAR BUILDER AND RAILROAD JOURNAL

JULY, 1896.

MASTER CAR BUILDERS' ASSOCIATION

Proceedings of the Thirtieth Annual Convention.

The thirtieth annual convention of the Master Car Builders' Association was called to order at Congress Hall, Saratogo, N. Y., June 17, 1896, at 9.30 a. m., President Lentz in the chair. After an opening prayer by a local pastor, Col. H. S. Haines made an interesting address, in which he dwelt at considerable length on the progress in car construction since the days when passenger cars were little better than the cabooses of to-day. He said that the master car builder of to-day must be an engineer, an architect and an artist in order to produce the magnificent, safe and comfortable passenger equipment of to-day. In freight-car construction the great reduction of dead weight in proportion to load, is to be credited to the master car builders and still further progress in this direction is desirable in both freight and passenger equipment. With the high speeds desired to-day, the capacity of the most powerful locomotives is taxed to haul the trains required and if the weights of cars could be so reduced as to enable a locomotive to haul six cars where five are now pulled, the gain would be a decided advantage.

He was followed by President Lentz, who made his annual address. In it he said that in the 12 months from June, 1895, to June, 1896, there had been 100 per cent. more cars built and contracted for than in the preceding 12 months. He congratulated the association on the fact that its standards had been better observed this year than at any time in the past. The code of rules reconstructed on the lines suggested by the Southern and Southwestern Railroad Club would be offered to the association for adoption. One striking suggestion he made was in relation to the decisions of the Arbitration Committee. Last year the committee passed on 330 cases, of which two roads were interested in 19. As these decisions involved much labor and expense he recommended that a road taking a case to the committee should remit with the papers and correspondence relating thereto a check for \$10.00, which would be deposited in the treasury of the association.

The secretary's report showed a total membership last year of 372 and at the present time of 388. There are seven additional roads represented in the association, and the total cars represented at present number 1,269,291. The cash received by the secretary during the year was \$3,979. The treasurer's report shows a balance on hand June 11, 1895, of \$4,916.22, and on June 16, 1896, of \$5,509.91.

The dues for the year are fixed at \$5.00, as heretofore.

The Auditing Committee was appointed as follows: E. W. Grieves, J. N. Barr, T. Fildes. They reported later that all accounts had been found correct.

Committees on resolutions, nominations and obituaries were also appointed.

Under the subject of new business, Mr. F. W. Lane was elected an associate member. It was decided to hold two sessions of the convention per day. The formality of a roll call will be dispensed with at future conventions and members requested to turn in their names on cards to be provided by the secretary. The question of the proper loading of logs and rails on cars is so pressing that a committee was appointed to report at a late session of this convention. The committee consists of Messrs. Leeds, Bush, Lewis, Day, Stark, Haskell and Collier.

A resolution strongly endorsing the timber tests conducted by the Forestry Division of the U. S. Department of Agriculture was passed unanimously. The New York Central & Hudson River Railroad extended the courtesy of transportation to mem-

bers, and the Delaware & Hudson Canal Company tendered an excursion to Lake George for Saturday to members and friends. These courtesies were duly acknowledged.

A letter was read from the Master Blacksmiths' Association, asking that members urge their Master Blacksmiths' Convention be held in Chicago in September. The communication was favorably received and members urged to act in accordance with its request.

Triple Valve Tests.

The reports of committees were next taken up. The first one of importance was that on "Triple Valve Tests." The committee is a standing one, and it explained that it had received no valves for test during the year and therefore had no report to make.

Wheel and Track Gages.

The Committee on Standard Wheel and Track Gages, which was appointed to co-operate with a committee of the American Railway Association, reported that certain tests were in progress and that no report could be made at this session.

Tests of Air-Brake Hose.

The noon hour having arrived, topical discussions were taken up, under a rule which allowed ten minutes only to each topic, unless the time was extended by a vote of the association. The first subject was "Tests of Air-Brake Hose." Mr. Barr opened the discussion by stating that he had for some time been testing hose by fixing one end and attaching the other to a moving cross-head which traveled far enough to give the hose an amount of distortion almost sufficient to kink it. Different brands of hose varied to such an extent that the range of endurance was from 200 to 2,800 hours. The hose almost invariably failed near the nipple. While not convinced that this form of test is all that is desired, Mr. Barr is of the opinion the results show clearly that in the effort to make hose that will stand 700 pounds' pressure, the manufacturers have made the hose too stiff and inelastic. He is now trying cotton-covered hose capable of standing 300 pounds air pressure and of much more elastic nature than the common hose. Numerous questions were asked by members, in answering which Mr. Barr stated that the failures at the end compared to those in the middle were as 4 to 1. Mr. Schroyer considered that the quality of the rubber determined the flexibility and durability of the hose.

Pressed Steel Trucks.

The next subject was "Pressed Steel Trucks." Mr. Higgins said that there were 90,000 pressed steel trucks in service in this country and that the type had passed beyond the experimental stage. Among the advantages of the pressed steel truck he enumerated the decreased weight, fewer parts, less liability of getting out of square, and improved riding of cars. The saving in weight varied from almost nothing to as much as 2,000 pounds, according to the design of the diamond-frame truck to which it is compared. The fewer parts meant a saving in the cost of inspection and repairs, and the squareness of the truck resulted in fewer sharp wheel flanges and easier haulage. The improved riding of the cars, due in part to placing the springs over the axle-box, is attested by the disposition of the train men to ride on such cars when not in the caboose. The claim for reduced cost of repairs is supported by several cases, in one of which only \$1 was spent on these trucks for every \$10 expended in repairs to an equal number of diamond trucks. The two kinds of trucks were in the same service, but the pressed steel trucks were only one year old while the others were three years old. The arguments in favor of the diamond-frame truck are the saving in first cost, repairs more easily made after wrecks, greater facility for inspection of wheels, and the ease with which wheels can be changed. Of these the facility for inspection and reduced first cost are admitted, but the experience of Mr. Higgins is that the pressed steel trucks come out of wrecks in better shape, and that it frequently happens that cars so equipped can be hauled from a wreck on their own trucks when diamond trucks are a total wreck. The difference in the cost of changing wheels he also considers to be less than is generally supposed. For large capacity cars, the pressed steel truck seems to be far in the lead. There is, fur-

thermore, a possibility of arriving at a standard truck through this type.

Mr. Sanderson had tried pressed steel trucks in heavy service, and the results were not satisfactory. He does not consider that a modern pressed steel truck should be compared with old diamond trucks, but with the most modern and best designed of that type. The changing of wheels at small interchange points he held to be a difficult matter with pressed steel trucks. Mr. Rhodes called attention to the fact that in modern diamond-frame trucks the number of parts had been generally reduced.

Break-in-Twos.

The next subject discussed was "Break-in-twos." Mr. Waitt started the discussion by stating that he had been investigating the matter on the Lake Shore road and had regular reports of all break-in-twos, whether resulting in damage or not, and he had found that for the first five months of 1896 the number had been 467. This included yard and road service. Of these break-ages 45 per cent. were between cars equipped with link-and-pin couplers or where an M. C. B. coupler and a link-and-pin bar were coupled together. Knuckle opening in M. C. B. bars was responsible for 26½ per cent. of the total failures and 21 per cent. were caused by the bar pulling out through either a tail bolt or its key breaking or the latter falling out. The remaining 7½ per cent. of breakages were from miscellaneous causes. Of the failures from knuckle opening he had found most of them due to a bad adjustment of the unlocking gear, there not being slack enough in the chain. He had made it a rule that all coupler chains should have at least 2½ inches slack in the normal position and 3 inches if possible.

Mr. Day said that his road used only the Janney, and he could only speak of that bar, but he had found that the old small unlocking pin never gave any trouble, while the later and larger pin frequently jumped and allowed the coupler knuckle to open. Mr. Sanderson said their greatest trouble was with locks jumping up on M. C. B. couplers on the back end of tenders. Mr. F. H. Soule says that the pin will also creep up. The latest Janney lock gives no trouble whatever. He found the most expensive break-ages due to failure of tail pins and that pocket drawbars were all right. Mr. Leeds said that his greatest troubles with the tail pins occurred where pins 1½ inches or 1¼ inches in diameter had been substituted in interchange for the regular 2-inch pins. Mr. Rhodes considered manufacturers should give attention to the lifting or jumping of locks, and also to the unlocking of couplers with toggles on the locks that could be operated by a severe shock on the other end of the car. Mr. Barr also receives reports of all break-in-twos on his road and endorsed what had been said about pins creeping up and jumping. He found four times as many failures of this kind in M. C. B. bars as in link-and-pin bars. Mr. Potter said it was the duty of the members to place all available information in the hands of the manufacturers, for the railroads alone had the benefits of experience in the use of the bars. Mr. Bronner said that the experience of the Michigan Central had led them to devote more attention to the maintenance of the unlocking gear. The subject was finally disposed of by making it a subject for a committee to report on next year.

Protective Paints.

A short discussion took place on the kind of paint best suited to the protection of trucks from rust, but Mr. Barr cut it short with the sensible suggestion that as the only trouble occurred from the salt drippings from refrigerator cars, it would be easier to keep the drippings off the trucks than to protect them by paint or japan.

Standards and Recommended Practice.

At the afternoon session the first report to be read was that on the changes in standards and recommended practice. A summary of the report is found elsewhere in this issue, and the recommendations of the committee were endorsed with a few minor changes in wording, and ordered submitted to letter ballot.

Mounting Wheels.

The report on "Mounting Wheels," also published on another page, was discussed briefly, particularly as to the need of the "reference gage," and finally ordered submitted to letter ballot,

The report on "Metal Under Frames for Freight Cars" was read and the discussion postponed until a later session.

THURSDAY'S SESSION.

This session opened by the secretary reading a letter from Mr. R. H. Wilbur, of the Lehigh Valley Railroad, accompanied by considerable interesting correspondence relating to the operation of English railway clearance houses for rolling stock, and the methods of inspecting and interchanging cars in England.

Location of Air-Brake Cylinders.

The report on the "Location of Air-Brake Cylinders on Freight Cars," an abstract of which we will publish next month, was next read. This report advocates that cylinders on all freight cars, where possible, be located approximately under one of the side sills, and many members opposed it in the belief that the rods and levers cannot be made uniform. On the other hand there were several members who appreciated the convenience it affords for repairs and favored the recommendations. The discussion was cut short by the special order of business at 10 o'clock—the rules of interchange.

Rules of Interchange.

Mr. Adams introduced the subject by giving the history of the inception of interchange agreements, and introduced Mr. John Mullen, now President of the Connecticut River Railroad, who presided at the first meeting called for the purpose. He made a brief address. The report of the Arbitration Committee was then read and used as a basis for revision, and as this report was framed on the rules outlined by the committee of '21, the work of revision was, of course, conducted on the lines of owner's responsibility. The entire code as recommended by the Arbitration Committee was passed without change except in two paragraphs, which change the committee itself suggested. Other changes were proposed by members, but they were voted down with great regularity. The first of the two changes made was the striking out of the clause fixing the responsibility for cars destroyed upon tracks of roads not members of the association, upon the delivering road. The second change was to add a clause to Rule 5 (new code) by which switching roads are made responsible for new defects which occur on cars while in their position, and they are prevented from rendering bills for parts broken on their roads. The prices given in the committee's report were revised by a special committee that reported at a later session. It was also decided that rulings of the Arbitration Committee during the year on points not fully covered by the rules should be in equal force with the regular rules until the end of the year.

The Metric System.

Noon-hour discussions were next taken up, the metric system of weights and measures being the first subject. Mr. Higgins stated that Wm. Sellers & Company had used the system in its injector department for 20 years and did not consider it a success. Several other members spoke against the system and finally the association adopted a resolution condemning any obligatory use of the system, such resolution to be sent to the committees and individuals in Congress interested in the bills which are at present before that body.

Double Buffer Blocks.

The use of double buffer blocks in connection with M. C. B. couplers was next discussed. Mr. E. D. Bronner advocated them, claiming that the cost is about \$5 per car and the reduced cost of maintenance of the draft gear will offset this. The horn of the coupler is not suited to take the buffing strains, as it is not in direct line and is not of sufficient area. Properly placed the buffer blocks had not in Mr. Bronner's experience given any trouble in coupling on curves. Mr. Sanderson thought the buffers the cheapest thing available to take the buffing strains. Mr. Rhodes said that before the M. C. B. couplers had been adopted the buffer blocks were used in the East and were only kept off Western equipment because of the prejudice against them, they being known as "man-killers." When the M. C. B. coupler was adopted the Western roads hoped to be able to employ the buffer blocks, but the Eastern lines discarded them at this time, and managers of Western lines quoted this action

as a reason why they should not put them on. The C. & Q. R. R. decided a few months ago that all its cars with M. C. B. couplers should be fitted with buffer blocks. Mr. Mitchell said that of the 44,000 freight cars owned by the Erie Railroad only about 2,000 cars were without buffer blocks, and it was a very unusual thing to have an M. C. B. coupler head broken off any of their own cars. Mr. Schroyer believes in buffer blocks. Experiments made by him show that a drawbar spring of 20,000 pounds capacity is entirely compressed by a car and its load having a total weight of 40,000 pounds striking a car of the same weight at a speed of four miles per hour. As these speeds are exceeded in nearly every switching movement, the need of buffers is apparent. A vote was passed to the effect that the question of the use of buffer blocks in connection with M. C. B. couplers should be submitted to letter ballot for recommended practice.

Location of Air-Brake Cylinders.

The afternoon session opened with a continuance of the discussion on the report on the location of air-brake cylinders. Mr. Rhodes described some experiments being carried out on the C. & Q. R. R., in which a plain tee was placed in the train pipe instead of the drain cup, and the cup itself located at an angle in the branch pipe and so designed that the screen can be readily removed for cleaning. Mr. Rhodes stated that he was not sure of the wisdom of making any change, but gave the description as a matter of possible interest. Mr. Cloud was requested to state the view of the manufacturers in regard to the construction of the drain cup and said that in their opinion the difficulties were overcome by the adoption, about two years ago, of a stronger screen, made of perforated metal. The stopping up of screens only occurred in parts of the surface not in the direct path of the air, and did not become serious enough to prevent action of the brake. As for leading the branch pipe out of the top of the cup, it required several more joints and unless it is a real necessity it is undesirable.

Axle and Journal Box for 80,000-Pound Cars.

The next report to be read was that on the "Axle, Journal-box, Bearing and Wedge for 80,000-Pound Cars," an abstract of which we publish on another page. This admirable report was so complete that it did not admit of much discussion, and after a brief consideration it was decided to submit the designs to letter ballot as recommended practice for one year, and the standing committee on standards were instructed to report on their behavior in service at the next convention, with a view of adopting them as standards if satisfactory.

FRIDAY'S SESSIONS.

Metal Underframes.

The report on metal underframes for freight cars was again discussed, the members having in the meantime visited the various steel cars on exhibition. Mr. Sanderson spoke of the prospect of scarcity of wood in the near future and the tendency toward lower prices for steel shapes as favorable to the prospects of the steel car. He objected to the use of truss rods in steel cars. The greater ability of the steel car to resist the forces of collision is attested by experience with metal tender frames. Mr. Barr said the steel-car question was growing and while the cost was in the way now, the day was coming when it would not be; he therefore moved that five members be appointed, each working independently, to present a design of a steel underframe at the next meeting. This motion was carried and the executive committee will appoint the five persons later. Mr. Bush said that while the cost of the steel cars was now an obstruction to their adoption, the present difficulties would be overcome only by earnest individual effort, and he had therefore promptly seconded Mr. Barr's motion.

Mr. Joughins gave the results of the use of steel cars on the Norfolk & Southern. A sample car built four years ago had not had one cent expended on its frame for repairs. The road had a number of the cars built last year at a cost of from \$40 to \$50 more than the cost of wooden cars. The weight of the flat cars without brakes is from 19,500 pounds to 20,000 pounds, and the capacity 40,000 pounds. He thinks rivets may be all right but

believes that properly fitted bolts are fully as acceptable if not actually better. He does not believe it is necessary to go to patented shapes or construction to obtain a good car. Mr. Stirling, of the Universal Construction Company, claimed that patented articles had contributed much to the progress in railroading, and that there were no serious difficulties in the way of using patented shapes in car construction, as the very existence of the business of a concern advocating such shapes depends on the availability of materials for repairs.

Laboratory Tests of Brake Shoes.

The report on "Laboratory Tests of Brake Shoes" was next read. Before discussing it the report of the joint committee on road and laboratory tests of shoes was read. It stated that present knowledge indicate that on chilled cast-iron wheels in freight service, wrought iron shoes, Congdon, hard and soft cast-iron shoes will give the best service, and at present prices, their economic value will be in the order named. On chilled cast-iron shoes in passenger service, where the pressures and speeds are higher, wrought iron, pressed steel, Congdon, hard and soft cast-iron shoes will give good results and their value is in the order named. For steel-tired wheels no recommendation can be made because the quality of the steel has so much influence on the action of the various shoe metals. The discussion brought out little additional information except that Mr. Barr stated he had found the varying thickness of flanges on cast wheels made it inadvisable to use flanged shoes on those wheels. The committee on brake-shoe tests was made a standing committee.

Passenger Car Ends and Platforms.

The report on "Passenger Car Ends and Platforms" was next presented. An abstract of this report will appear in our next issue. The design recommended by the committee embodied good points from many of the platforms in use at present and in the discussion the committee said that the Eastern Railroad Association had given the opinion that it infringed in some respects on existing patents. The design was therefore presented as representing the best practice, and roads would understand that if they used it they would have to pay royalties on some features of it.

Freight Car Doors.

The report on "Freight Car Doors," published elsewhere in this issue, was next taken up. In the discussion an attempt was made to have the committee continued for another year to present a design of car door and fastenings free from patents and capable of meeting all requirements, with a view of having the design adopted as a standard. A parliamentary tangle ensued which was straightened out by referring the matter to the Executive Committee.

Power Brakes and M. C. B. Specifications.

The noon hour having again arrived, topical discussions were taken up, the first one being, "Will a railroad company be conforming to the law requiring power brakes on cars, regardless of whether its brakes meet the specifications adopted by the M. C. B. Association?" The legal aspect of the question did not receive much attention, but the discussion was most emphatically in support of the resolution with which it closed, and which was proposed by Mr. Mitchell, namely, that "It is the sense of this meeting that brakes whose triples have not met the test of the M. C. B. Association shall not be considered as proper brakes for use on railway equipment."

Pockets vs Tail Pins.

Mr. Hennessey presented an argument in favor of pockets instead of tail-pins in draw-gears. He said that the only arguments for the tail-pin were first cost and ease of removal for repairs; every other point is in favor of the pocket. As showing the greater safety of the latter, he said that of the 27,880 cars on the C. & St. P., 95 per cent. were equipped with pocket bars, and in two years only 14 had failed, causing a total damage of \$871. In the 5 per cent. equipped with tail-pins, there were 17 failures, costing \$2,300. Mr. Mitchell offered a resolution that it was the sense of the meeting that tail-bolts should be abolished, and it was carried.

Mending Air-Broke Hose.

The next topic was the mending of air-brake hose, and Mr. Rhodes produced several samples that had been spliced or in which punctures had been closed with cement, at costs ranging from 7½ cents to 10 cents. As the first cost of the hose is 70 cents the saving is considerable.

Lead Lined vs. Filled Brasses.

A discussion on solid lead-lined brasses vs. filled shell bearings for freight cars brought out the fact that either worked well when properly made, the chief trouble with the shell brass being the small bearing on the axle if the filling is melted out by a hot journal. On the other hand if the shell is rightly made even this difficulty can be overcome. The lead-lined solid brass is evidently the favorite, however.

Substitution of Triples.

After discussing the right of a company to substitute one make of triple valve for another in cleaning or repairing brakes under the interchange rules, it was decided that such substitution is not proper repairs.

Uniformity in Car Construction.

Mr. Soule opened a discussion on the question: "Is it desirable to have greater uniformity in car construction?" He suggested adding to the present standards certain standard dimensions for center plates and side bearings. While not ready for such a step now, the association would also, he thought, find it desirable at some future time to adopt standard shapes for metal underframes, with several standard lengths for each shape. Mr. Peck thought the draft rigging should be standardized, and Mr. Hennessey urged standard sizes of iron for arch bars.

Handholds.

The afternoon session opened with a consideration of the report on "Handholds and Heights of Drawbars." The recommendations of the committee were amended by omitting the handhold in the center of the end of the car, 4 feet 3½ inches above the rail.

Coupler Unlocking Gears.

The report on "Unlocking Arrangements for M. C. B. Automatic Couplers" was next presented and discussed. The report gave considerable information about present devices, but recommended no particular design, and members desired from the committee a design which would meet the requirements of as many couplers as possible. They were consequently instructed to prepare such a design and present it next year.

Stenciling Cars.

The report on "Stenciling of Cars," found elsewhere in this issue, was next received and the recommendations contained in it ordered submitted to letter ballot.

Mr. Leeds, as Chairman of the Committee appointed on Wednesday's session to report on "Loading Poles, Rails, Etc.," presented the report, the recommendations in which will be submitted to letter ballot.

Resolutions of thanks to those who had extended courtesies to the association were carried unanimously. The election of officers resulted as follows: President, S. A. Crone; First Vice-President, E. D. Bronner; Second Vice-President, C. A. Schroyer; Third Vice-President, J. T. Chamberlain; Treasurer, G. W. Demarest; Executive Committee, G. W. Rhodes, P. Leeds and M. M. Martin.

A call for suggestions for the next place of meeting led to the proposal of the following places: Old Point Comfort Niagara Falls, Chicago, Denver, Montreal.

Adjourned.

On May 7 the Michigan Central made a fast run over its Canada Southern division, covering the distance from Windsor to Fort Erie, 229.4 miles, in 3 hours, 34 minutes, 59 seconds, or at the rate of 64.02 miles per hour. One stop was made at St. Thomas, of 4 minutes and 40 seconds, so that the average speed for the actual running time was 65.45 miles per hour. The train consisted of three cars weighing 230,000 pounds, or 115 tons, and was hauled by a 19 by 24 ten-wheeled engine with 68-inch drivers, carrying 160 pounds of steam. The engine weighs 96,300 pounds on the drivers and 27,200 pounds on the truck, or a total of 123,500 pounds.

AMERICAN RAILWAY MASTER MECHANICS' ASSOCIATION.

Proceedings of the Twenty-ninth Annual Convention.

The twenty-ninth annual convention of the American Railway Master Mechanics' Association opened in Saratoga, N. Y., June 22, 1896, President Blackall presiding. After an opening prayer the association listened to an address of welcome from the president of the village. Mr. Blackall then presented his annual address. It was business-like and pointed, and besides touching on the work of the association and of the railroad clubs, dwelt upon some of the advances in railroad practice during the year, among others improved counterbalancing of locomotives, reduction of the weights of reciprocating parts, and rating engines on the tonnage basis. He said that economy had been the watchword with all railroad officials during the year, and a better fuel efficiency is being sought everywhere. Another important matter to which attention is being directed is the improvement in the condition of the men in the employ of the railroad companies.

The Secretary's and Treasurer's reports showed the membership to be 683 and the balance in the treasury \$313.34. The Secretary's report called attention to the fact that the association scholarships at the Stevens Institute had not been fully improved, the chief difficulty being that after one year's shop experience (as required by the association) the candidate is not familiar enough with his scientific studies to meet the severe entrance examinations.

The whole matter was referred to a committee that at a later session made a report in which they notified the Association that at the next meeting they would move to amend the constitution by modifying Article 7 to provide that if the scholarships are not filled at the spring examinations by sons of members, railroad employees or sons of railroad employees may compete at the fall examinations.

Another amendment to the constitution presented last year was adopted at this time, by which the Secretary of the association was made an appointee of the Executive Committee. After this action another amendment was proposed for action next year, by which the Secretary is not to be a member of the Executive Committee, and providing for three Vice-Presidents instead of two as at present.

The attention of the association was called to a report of the New York Railroad Commission, in which radial stay boilers were condemned as less safe than crown-bar boilers. The subject was made a special order of business for Tuesday at noon, and the Commission invited by telegram to be present.

A motion condemning the obligatory use of the metric system was adopted. A resolution endorsing the work of the Master Blacksmiths' Association was passed. Mr. Henderson read a letter from Mr. Bond, of the Pratt & Whitney Company, in which it was stated that the concern had overcome the difficulties in sawing the finest slots in the new decimal gage and would in a few days be ready to deliver the first lot of 500 gages. The Schenectady Locomotive Works invited the association to visit the works. This invitation was accepted and the time fixed for 2:30 Tuesday afternoon.

Exhaust Pipes and Steam Passages.

The first of the reports from committees to be considered was that on "Exhaust Pipes and Steam Passages," a summary of which we publish on another page. This valuable report is voluminous and accompanied by many diagrams, and as none of the members had received any copies of it before coming to the meeting, the discussion was altogether in the nature of interrogations addressed to the committee. The committee was continued for another year with the understanding that a number of roads would be asked to make practical tests of pipes and stacks of the form recommended by it.

Counterbalancing Locomotives.

The report on "Counterbalancing Locomotives," found elsewhere in this issue, was next presented. The Chairman, Mr. Herr, explained that the rule recommended in the report, while undoubtedly correct in principle, should be tested in practice, in order to make sure that the coefficient of $\frac{1}{100}$ of the weight of the

engine was best. He said that whether that amount of the reciprocating parts could be left unbalanced or not might be found to depend in a measure on the length of the rigid wheel base and its effect in resisting the lateral swaying of the engine. It might in a similar manner be influenced by the weight on the truck. Mr. W. H. Marshall said that it might also be influenced by the total length of the engine; that there were, for instance, many 10-wheeled engines running weighing from 100,000 to 130,000 pounds, and, on the other hand, many modern 8-wheeled engines of the same weight. The latter were, however, considerably shorter than the former, and the difference in distance from the center of moments of such heavy parts as cylinders at the one end, and foot plates, etc., at the other, would have an effect on the coefficient. Mr. Leeds said that in a number of cases of bent rails he had investigated, the damage had always been done at speed in excess of 48 miles per hour. In each case the engine had the correct total amount of counterbalance, but it was not properly distributed among the wheels, there being a shortage in the main wheels and an excess in the others. After a general discussion on the present practice in counterbalancing, the committee was continued and instructed to make arrangements with a number of roads for practical trials of the proposed rule during the year and report the results at the next convention.

Slide Valves.

The third report to be considered was that on "Slide Valves," which we publish in abstract. Mr. Quereau called attention to the fact that the Allen valve not only had the advantage of the large port opening at early cut-off, but that it was possible with it to greatly reduce the lead, with the result that at a six-inch cut-off the exhaust opening could be delayed about three-quarters of an inch and the exhaust closure delayed nearly one inch, resulting in an increased mean effective pressure of from five to eight per cent. Mr. Herr said that on the Chicago & Northwestern Railway they had been able to add four or five cars to a 40-car train by reducing the lead with a plain valve. Mr. Forney asked if members had found any saving in fuel resulting from the use of the Allen valve. Mr. Forsyth said that he was also interested in that point and was sorry the committee had not considered it in the report. Mr. Vauclain and Professor Goss both testified to the fact that engines were frequently run with too early a cut-off, and that there was no economy in making it less than six inches. Considerable discussion took place on the appearance of some of the indicator diagrams in the report and the fact was brought out that the springing of the valve gear of the average locomotive, made the duplication of results extremely difficult and would probably explain the vagaries in the diagrams.

TUESDAY'S SESSION.

Reciprocating Parts.

Tuesday's session opened with the reading of the report on "Reciprocating Parts," which will be published in abstract in a later issue. The malleable iron piston of the Norfolk & Western Railroad, illustrated in the June issue of this journal, attracted considerable attention. Mr. Vauclain said he had used a somewhat similar piston of cast steel with the bearing ring screwed on. Hollow piston rods were mentioned as a means of reducing the weight of reciprocating parts, but the cost is considerable. Mr. McKenzie called attention to the fact that some of the illustrations in the report showed no shoulders at the taper fit of the rod in the piston head and crosshead. He had not been able to make that construction a success. Mr. Forsyth said that its success depended on the density of the materials employed. If the metal surrounding the rod is soft and ductile, it will stretch and produce a loose fit, but if hard enough the fit will remain perfect. Mr. Thomas, of the Southern Railway, said he had used steel pistons with cast-iron rims cast on to them to obtain a suitable metal for contact with the bore of the cylinder.

Cylinder Bushings.

The report on "Cylinder Bushings," published on another page, led to animated discussion on the best material for cylinder castings. Some members thought that if a strong, tough iron was employed not only the strength but also the wearing qualities would

be all that is required, and that the false valve seats and bushings should not be applied to new engines. Cases were cited where engines had run from 14 to 20 years without being bushed. The advocates of bushing new cylinders held, however, that powerful modern engines had given trouble from the breaking of cylinders and saddles and that, when the metal is made strong enough to resist the strains to which it is subjected, it is not found to have as good wearing qualities as in older and smaller engines. The bushings and false valve seats permit the use of a strong metal for the main casting, regardless of its wearing qualities, while these parts can themselves be made of harder and more durable metal than it would ever be possible to use in the main casting. Some cases of reduced fuel consumption on account of the reduction of the friction by the use of hard bushings and valve seats were cited. The cost of bushing is not great, one member saying he could bush a 20 by 24-inch cylinder for \$17, and Mr. Vauclain stating that the Baldwin Company's price for bushing the cylinders and valve chambers of a four-cylinder compound locomotive (six bushings) is \$125.

Hub Liners.

The report on "Hub Liners" gave several examples of the best current practice. The discussion touched on the babbitting of journal box faces, with which some members had excellent results. Some were in favor of cast iron and others advocated brass as the material for liners. One member uses a liner in two parts bolted together by means of lugs so far from the center of the axle as to be beyond the wheel hub. They clamped firmly on the axle and had the advantage that they could be applied without taking out the wheels. Some members use the liners on new engines, others only in repairs.

Radial Stay vs. Crown Bar Boilers.

The noon hour having arrived, and Mr. Rickard, of the New York Railroad Commission, being present, the question of the relative safety of radial stay and crown bar boilers was discussed. Mr. Rickard read from his report the paragraph that had attracted the attention of the association. It is as follows:

"In the explosions of locomotive boilers, which have taken place in this State, in several years past, many of them have been of boilers with crown-sheets supported by radial stays. While there have been explosions of boilers where the fireboxes have been constructed with crown bars and rivets, the complete destruction of fireboxes in the former type was absent in the latter. Much has been said, and more may be said, as to the relative merits of crown bars and radial stays in such construction. The Board believes this is a subject which should receive the earnest consideration of all persons engaged in boiler construction."

The discussion was almost wholly on the relative merits of the two general types and nearly all of the testimony was in favor of the radial stay boiler. It was shown that instead of the Commissioner's report being in accordance with facts the very reverse of its statements was true, the radial stay firebox often coming down when hot without excessive damage, while the crown bar boiler usually exploded disastrously when the water was allowed to get too low. The Commission had apparently arrived at its conclusions from experience with wide firebox engines, and had not gone into the matter far enough to ascertain whether the trouble was due to faulty construction, imperfect inspection and maintenance, or defects in the general type, but unfortunately these things did not receive consideration in the discussion. The association confined itself to a comparison of the two general types, and terminated the discussion by passing a resolution to the effect that the radial stay boiler is as safe as the crown bar boiler, is easier to keep clean, and more economical in repairs.

Steam Pipes and Joints.

The last report to be considered at this session was that on "Steam Pipes and Joints." The discussion was brief, and did not bring out much that was not already touched on in the report. The report appears elsewhere in this issue.

WEDNESDAY'S SESSION.

The Apprentice Boy.

The first report at this session was on "The Apprentice Boy." This report dwelt chiefly on the possibility of giving apprentices opportunities for instruction in the sciences and the methods to be

employed in furnishing the instruction. Mr. Briggs said that employers had but little control over the boys and the trouble was chiefly with the labor organizations. President Smart, of Purdue University, said that Purdue was in a helpful mood, and if there was any work which it could undertake for the better instruction of apprentices it would gladly co-operate with the association. The university is already perfecting the plans for a mechanics' institute, but feels that in the instruction of apprentices it must first find out what was needed. Mr. Forsyth noticed that the committee said they could not recommend an apprentice system. He believes they can, and that they should be requested to report at the next convention an outline of shop instruction and also an outline for technical instruction.

Mr. Miller said that apprentices should be required to come up to a good moral and physical standard, and in dealing with them it should be borne in mind that some were ambitious, and would endeavor to fit themselves for something higher than a mechanic, while others would be content to be good workmen. Mr. Herr said that a proper shop training is the most important consideration, and it appeared to be wholly ignored by the committee. The great question is how can we handle the boys in the shop so that they can most improve their opportunities. Mr. McKenzie said that his practice was to make a careful selection from among the many applicants, and to give each boy a trial of one year at a certain pay. If at the end of that period he had made creditable progress his pay was increased. If his work was unsatisfactory he might be permitted to continue for another year, but if he then failed to make a good showing he was dropped. Mr. Barr thought the subject a large one, and believed that the various railroad clubs could discuss it with profit. Mr. Quayle thought it important to advance the boys as rapidly as their ability and efforts warranted, and not discourage them by keeping them on one class of work longer than was right. On the C. & N. W. Ry. he divided apprentices into two classes—those with a common-school education, who were carefully instructed in regular shop practice—and those with a technical education, who were given a special shop course, and to whom were also assigned special investigations and other work that would fit them for advanced positions.

Driving Box Wedges.

The report on "Driving Box Wedges" was next considered. Mr. McKenzie believed that stationary wedges to be successful should have wide faces. The frame jaws should be at least 5 inches and the shoes 8 inches wide. He recently had some 10-wheeled engines built with front and back pedestal jaws parallel and the main jaws taper. The greatest trouble with fixed wedges was in the use of shims, there being considerable pound at the boxes before even very thin shims could be inserted. Mr. McIntosh said that the way to overcome that trouble was to fit the stationary wedges when new with shims, say $\frac{1}{4}$ inch thick, and then to have other shims varying in thickness by hundredths of inch. These could be substituted for the original shims when the least pound appeared.

Engine and Tender Steps, Etc.

The report on "Engine and Tender Steps" published elsewhere in this issue was not discussed. The report on "Truck Brake Hangers" had not been printed. It was read, but the members were not, of course, able to discuss it. The report on "Locomotive Grates" was deferred until next year.

Thickness of Wheel Flanges.

The report on "Thickness of Wheel Flanges" recommended: 1. That the minimum thickness of leading engine truck-wheel flanges should be the same for both iron and steel wheels; 2. That the minimum thickness be 1 inch, measured at a point $\frac{1}{2}$ inch from the top of flange, as shown on the appended diagram, Fig. 3. In recommending that the steel-flange limit be the same as in cast iron, the fact that the strength of steel admits, with perfect security, of a thinner flange has not been lost sight of by the committee. The recommendation is based purely upon economical considerations as to tire wear.

Some members endeavored to have the convention go on record regarding the safety of a wheel flange $\frac{1}{2}$ inch thick, but the asso-

ciation refused to express an opinion, and passed a resolution to the effect that the minimum limit of flange thickness should be 1 inch, and that in the measurement of the flange the M. C. B. flange gage should be employed.

Boiler Tubes.

The report on the thickness of boiler tubes was adopted, and the standard of the association made to conform therewith.

Resolutions of thanks to all who had extended courtesies to the association were passed. The committee on subjects for next year reported twelve subjects, which were referred to the Executive Committee. A resolution was passed recommending that locomotive performance sheets be made out on the ton-mile basis instead of the car or train-mile basis.

The election of officers resulted as follows: President, R. H. Soule; First Vice-President, P. Leeds; Second Vice-President, R. Quayle; Treasurer, O. Stewart. The Executive Committee met after adjournment and appointed John W. Cloud as Secretary.

Mr. John McKenna and Mr. A. Galloway were elected honorary members. A test vote on the next place of meeting resulted in more than two-thirds of the votes being cast in favor of Colorado Springs. Other places mentioned were Old Point Comfort, Bar Harbor, Niagara Falls and Chicago.

Adjourned.

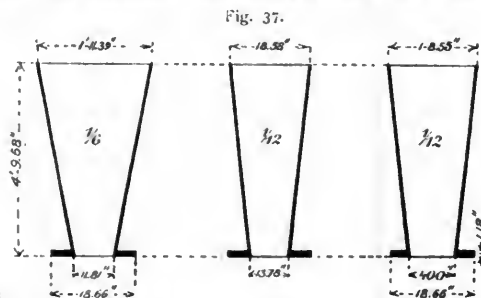
THE MOST ADVANTAGEOUS DIMENSIONS FOR LOCOMOTIVE EXHAUST PIPES AND SMOKESTACKS.*

BY INSPECTOR TROSKE.

(Continued from Page 86.)

V.—EXPERIMENTS WITH CONICAL STACKS WITHOUT WAISTS.

In order to determine the influence of the waist, similar experiments were made with the three funnel-shaped stacks, that have already been mentioned. Their forms are given in Fig. 37, and they



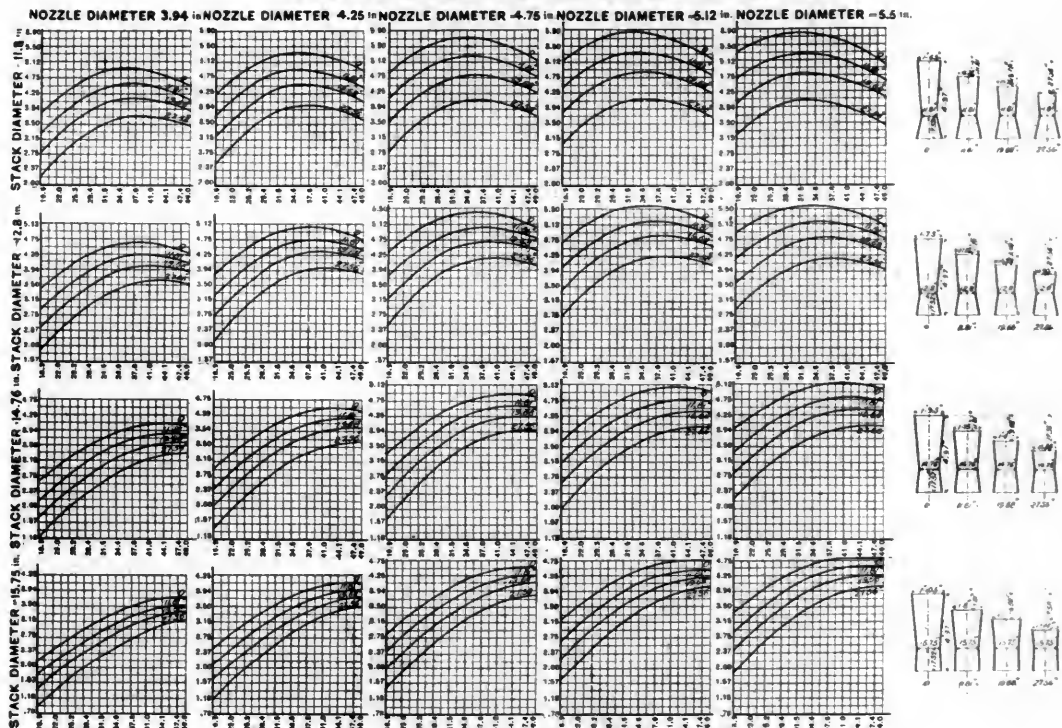
have exactly the same length from the bottom to the top, as the stacks with the waist inclusive of the foot or flare at the bottom, which was 4 feet 9.68 inches. At their lower ends, plates 1.18 inches thick, and 1 foot 6.68 inches outside diameter were riveted, in order that they might be placed upon the rings that have been described. These rings were packed with wicking in this instance also. The shortest distance of the nozzle from the smallest section of the stack was 1.38 inches, and was increased by steps of 1.57 inches to 31.3 inches.

The three stacks were also shortened three times. The results obtained are shown in Plates IV. and V. In these plates, as in Section II, the zero for the abscissas of the nozzle locations is taken from a point 17.52 inches above the lower end of the stack, in order that the abscissa values in all of the plates may be the same.

The most important results obtained with these funnel-shaped stacks are that, when the abscissas on the scale lines ranged from 23.62 inches to 30.37 inches, which means that the nozzle was from 6.1 inches to 21.85 inches below the actual bottom of the stack (that is, from its point of smallest cross-section), the vacuum lines were straight, which means that the vacuums produced varied directly with the increase in the nozzle distance. The relations existing between vacuum, nozzle pressure and nozzle position are here of the very simplest nature. In the diagrammatic representations

* Paper read before the German Society of Mechanical Engineers, and published in *Glasers Annalen für Gewerbe und Bauwesen*.

III. SHORTENED CONICAL STACKS WITH AN INCLINATION OF 1 IN 6.



IV. SHORTENED CONICAL STACKS WITHOUT WAISTS

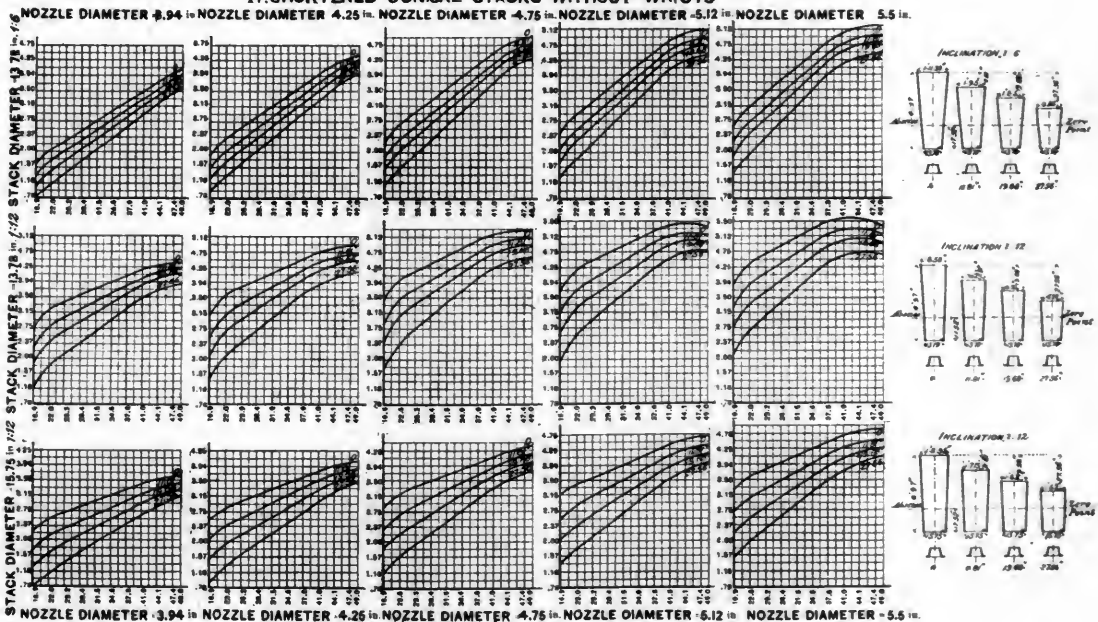


PLATE IV.—DETAIL DIAGRAMS OF THE HANOVER SMOKESTACK AND EXHAUST NOZZLE EXPERIMENTS.

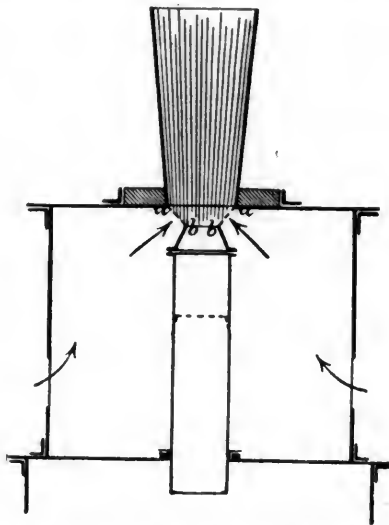
NOTE 1.—The abscissa r (nozzle positions) in stacks without a waist are measured from a point 17.52 inches above the bottom of the stack and 18.90 inches above the highest portion of the nozzle.

2.—The four curves drawn beneath one another are measured from the same base and represent the vacuums produced by the full length stack and the same shortened three times. The amount of each shortening (11.81 inches, 17.68 inches and 27.56 inches) is marked at the right hand end of each.

the first portion of the line, corresponding to nozzle positions of from about 18.9 inches to about 23.62 inches (which is from 1.38 inches to 6.1 inches from the smallest section), curves sharply.

This is because at first, when the distance of the nozzle from the opening to the stack is short, the indraft of air must take place through a small conical opening as shown at *a b* in Fig. 38, which

Fig. 38.



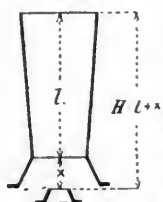
represents a vertical section of the current of steam as it enters the stack. At first, with that nozzle distance, the free section for the admission of air is not large enough to secure a high vacuum without obstruction. In the lines of the diagram in Plate IV, the straight lines are dotted out to the axis of ordinates, in order to show that with a higher vacuum the influence of a small area for the admission of air makes itself felt as well as when the vacuum is lower.

Table XV. (a) gives the values of the three principal points of the curve, and, under *b*, the limiting values of the vacuum for nozzle distances ranging from 23.62 inches to 39.37 inches, and consequently those distances between which the vacuum line is straight.

Plate IV. gives the results obtained with shortened stacks. Whence it appears that the straight lines recur in every length of stack that was examined. For the sharpest inclination of stack, namely that of $\frac{1}{4}$, even where the nozzle diameter was only 3.94 inches, the lines of the diagrams are nearly straight though the stack may have been shortened by 27.56 inches. In consequence of the very low vacuum at the outset (only 0.83 inch), the result is, for the reasons already discussed, that the first portion of the curve up to the 23.62-inch point is likewise straight, but it curves for the slightest shortening of the stack, a circumstance which is also of influence with both the other stacks. Plate IV. shows very clearly the very great influence exerted by the position of the blast nozzle on the height of the vacuum. It is also laid down in Table XVI.

Both of these tables show very conclusively how great is the influence of the different locations of the exhaust nozzles upon the action of the draft, and how it can be utilized for the total increase of the same. In order to obtain the figures for a slight increase, we

Fig. 39.



experimented with a funnel-shaped stack. It had an inclination of $\frac{1}{4}$, and its smallest diameter was 13.78 inches, the exhaust nozzle opening being 3.94 inches.

With the nozzle down 3.94 inches this stack, which had a length of 4 feet 9.68 inches, gave a vacuum of 1.97 inches as given by the lines of the diagram under IV. in Plate IV. If this stack be shortened 11.81 inches (300 millimeters) at the top, the same vacuum can be obtained by increasing the nozzle distance only 3.15 inches. With the stack shortened 19.68

inches at the top, the nozzle distance must be increased from 3.94 inches to 10.24 inches. In like manner with the total height of the

TABLE XVI.—SHORTENED STACKS.

(Conical Stacks Without any Waist.)
1. Stack Diameter = 13.78 in. Inclination of $\frac{1}{4}$.

Length of stack	Exhaust Nozzle Diameters.				
	Inches.	Inches.	Inches.	Inches.	Inches.
Length of stack	3.94	4.33	4.74	5.12	5.51
Full Length.....	Beginning..... 1.61	1.89	2.17	2.40	2.58
	Maximum..... 4.09	4.49	4.94	5.12	5.19
Shortened 11.81 in.	Beginning..... 1.31	1.57	1.81	2.00	2.19
	Maximum..... 3.94	4.35	4.76	4.92	4.96
" 19.68 in.	Beginning..... 1.10	1.30	1.50	1.69	1.85
	Maximum..... 3.80	4.21	4.61	4.74	4.81
" 27.56 in.	Beginning..... 0.83	0.98	1.14	1.30	1.42
	Maximum..... 3.62	4.02	4.37	4.48	4.49

Remarks: The starting or beginning value of the vacuum corresponds to the shortest distance of the nozzle below the smallest cross-section of the stack, or 1.38 inches. The maximum likewise corresponds to the greatest distance, or 31.30 inches.

2. Stack Diameter = 13.78 inches: Inclination of $\frac{1}{4}$.

Length of stack....	Exhaust Nozzle Diameters.				
	Inches.	Inches.	Inches.	Inches.	Inches.
Length of stack....	3.91	4.33	4.74	5.12	5.51
Full Length.....	Beginning..... 2.78	3.08	3.45	3.70	3.90
	Maximum..... 4.47	4.92	5.28	5.46	5.59
Shortened 11.81 in.	Beginning..... 2.23	2.52	2.87	3.13	3.30
	Maximum..... 4.31	4.69	5.11	5.20	5.32
" 19.68 in.	Beginning..... 1.85	2.09	2.42	2.64	2.80
	Maximum..... 4.17	4.51	4.94	5.02	5.07
" 27.56 in.	Beginning..... 1.18	1.42	1.73	1.93	2.09
	Maximum..... 3.90	4.22	4.62	4.79	4.71

Remarks: As in 1, it so happens with the others, that the maximum vacuum is obtained with the 5.12 in. nozzle, at an average of 3.15 in. and with the 5.51-in. nozzle at 26.58 in. measured from the smallest cross-section of the stack.

3. Stack Diameter = 15.75 inches: Inclination, $\frac{1}{4}$.

Length of stack.....	Exhaust Nozzle Diameter.				
	Inches.	Inches.	Inches.	Inches.	Inches.
Length of stack.....	3.91	4.33	4.74	5.12	5.51
Full length.....	Beginning..... 2.22	2.51	2.87	3.15	3.30
	Maximum..... 3.78	4.16	4.45	4.69	4.82
Shortened 11.81 in.	Beginning..... 1.73	2.00	2.32	2.5	2.72
	Maximum..... 3.48	3.88	4.25	4.45	4.57
" 19.68 in.	Beginning..... 1.30	1.54	1.81	2.00	2.17
	Maximum..... 3.30	3.70	4.06	4.23	4.35
" 27.56 in.	Beginning..... 0.79	0.96	1.18	1.38	1.54
	Maximum..... 3.15	3.52	3.80	4.10	4.13

Remarks: According to this the vacuum appertaining to the stack, that has been shortened 27.56 inches, increases if the position of the nozzle is dropped from 1.38 inches to 31.30 inches, as noted in Remark 2 with Table XVI. This is shown in percentages in Table XVII.

TABLE XVII.

Shape and size of stack	Diameter of exhaust nozzle.				
	3.94 in.	4.33 in.	4.74 in.	5.12 in.	5.51 in.
13.78 in. $\frac{1}{4}$ inclination.....	Per cent. 3.38	3.38	2.83	2.45	2.16
13.78 " " "	2.30	2.00	1.66	1.47	1.25
15.75 " " "	3.00	2.65	2.22	1.90	1.70

TABLE XVIII.

Nozzle Location, inches.	Total height of stack, inches.	Vacuum, inches.	Increase in the vacuum, per cent.
3.94	57.68 + 3.94 = 61.62	1.97	...
3.94 + 11.81 = 15.75	45.87 + 15.75 = 61.62	2.76	40
3.94 + 19.68 = 23.62	38.00 + 23.62 = 61.62	3.23	61

stack lessened by from 8.00 inches to 13.37 inches, the action of the draft remained unchanged:

Now if we reduce both of these shortened stacks back to their first total height, and allow for the original location of the nozzle

TABLE XV.—CONICAL STACKS WITHOUT WAISTS.

(a.) VACUUMS.

Stack.		Exhaust nozzle diameters.					Remarks.
		Inches.	Inches.	Inches.	Inches.	Inches.	
		3.94	4.33	4.74	5.12	5.51	
$\frac{1}{6}$	Beginning.....	1.61	1.89	2.17	2.40	2.58	1. The abscissas are calculated from a zero point 17.52 inches above the smallest section of the stack, or 18.9 inches above the top of the nozzle. 2. The shortest distance of the nozzle from the smallest section of the stack is 1.38 inches and the greatest is 31.39 inches.
	Crown.....	4.09	4.49	4.91	5.12	5.19	
	End.....	4.09	4.49	4.91	5.12	5.19	
$\frac{1}{12}$	Beginning.....	2.76	3.08	3.45	3.79	3.94	
	Crown.....	4.47	4.92	5.38	5.46	5.79	
	End.....	4.47	4.92	5.24	5.39	5.39	
$\frac{1}{12}$	Beginning.....	2.22	2.51	2.87	3.15	3.30	
	Crown.....	3.66	4.06	4.45	4.69	4.82	
	End.....	3.66	4.06	4.45	4.69	4.82	

(b.) Vacuums for Nozzle Distance of from 23.62 Inches to 39.37 Inches (Lines Straight).

Stack Diameter.	Nozzle Distance.	Exhaust Nozzle Diameters.					Remarks.
		Inches.	Inches.	Inches.	Inches.	Inches.	
		3.94	4.33	4.71	5.12	5.51	
13.78 $\frac{1}{8}$	23.62	2.17	2.48	2.85	3.08	3.27	The nozzle distance of 23.62 inches corresponds to a distance of 5.32 inches from the smallest section of the stack, and the distances given as 39.37 inches to one of 21.85 from the smallest section.
	39.37	3.41	3.86	4.37	4.69	4.92	
	Difference.	1.24	1.34	1.52	1.61	1.65	
13.78 $\frac{1}{12}$	23.62	3.35	3.70	4.13	4.41	4.61	
	39.37	4.21	4.63	5.12	5.35	5.55	
	Difference.	0.86	0.93	0.99	0.94	0.94	
15.75 $\frac{1}{12}$	23.62	2.62	2.95	3.27	3.54	3.70	
	39.37	3.35	3.72	4.09	4.39	4.57	
	Difference.	0.73	0.77	0.82	0.85	0.87	

to be increased from 11.81 inches to 19.68 inches (300 to 500 millimeters), the other ratios remaining unchanged, the vacuum will rise from 40 to 64 per cent. as shown in the following table No. XVIII.

This marked increase in the vacuum raises the question as to what is the most advantageous relationship to establish between the length of the stack l and the nozzle distance x (Fig. 30) if the total height H , that is the distance from the nozzle opening to the top of the stack, remains the same.

This question is answered by a reference to the examples given in Plate IV.

Let the smallest stack diameter be 15.75 inches and the nozzle diameter 4.74 inches. The total height of the stack measured from the nozzle is taken consecutively as 5 feet 2.00 inches; 5 feet 6.93 inches and 5 feet 10.87 inches.

We illustrate each one of these latter cases as examined in Fig. 40, and we see:

1. That, with the same total height, the vacuum increases with the decreasing length of stack, the nozzle distance being increased by equal increments.

2. That by increasing the total height the vacuum also increases.

This is not the only case for the stack with a diameter of 15.75 inches cited here, but also for all of the other stacks whose operation is represented under IV. in Plate IV.

From the foregoing, it follows as a matter of course that the stacks should be shortened at the upper end, while the smallest diameter remains unchanged. In this case the sectional area of the stack becomes more contracted relatively to the current of steam and therein lies the reason for the increasing vacuum as the distance down to the nozzle is made greater.

On the other hand, the question arises as to the effect of shortening the stack from the bottom, leaving the sectional area at the top unchanged. For this purpose we have brought together a group of a few stacks from which the curvature plates have been taken; they are shown in Fig. 41, and from them we see:

1. That with the decreasing length of stack and the corresponding increase of nozzle distance, the total height remaining unchanged, the vacuum decreases, and

2. That the vacuum increases again as the total height is made greater.

The decrease is, of course, so slight within the limits of possible practice, that it is of scarcely any importance at all, and may be entirely neglected. From all of these examples it seems that it is advantageous for a locomotive, next to a large stack, as we have

already discussed, (a) to choose a liberal total height, and of it (b) use about six or seven-tenths for the length of the stack itself, and from four to six-tenths for the distance from its base to the nozzle. A rule that will suffice for locomotive practice is to make the total height four or five times the smallest diameter, whereas the former practice has been to make it from six to six and a half times.

From the data given above it will be seen that the nozzle distance should not be made much more than one and a half times the smallest diameter of the stack. As a general thing, we will secure a suitable relationship if we make the stack from 39.37 inches (1 meter) to 47.42 inches (1.2 meters) long above the waist and the nozzle distance from 17.72 inches to 25.59 inches, which is equal to about $\frac{1}{2}d$, as shown in Fig. 42.

Fig. 42.

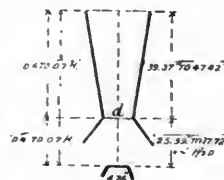
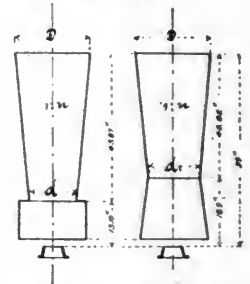


Fig. 43.

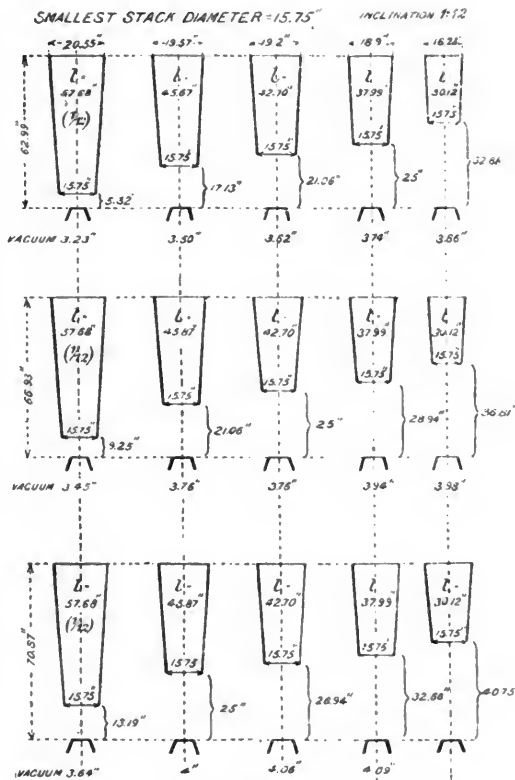


The influence which is exerted upon the action of the stack by the means and method of conducting the products of combustion and the steam to it, is shown in the following investigations:

(a.) Suction of the Products of Combustion by the Current of Steam.

The suction of the products of combustion into the smokebox or air into the apparatus is accomplished in the same way as gas or air would be drawn along by any roughened surface. The inner portion of the stream of steam carries no particles of gas or air with it, so long as it remains closed. Hence the greater the velocity of the steam, or the greater the velocity of the surface of the mantle, by just that amount will more gas be entrained, as is also shown in Section VIII.

Fig. 40.



(b.) Shape of the Foot of the Stack.

What influence does the shape of the foot of the stack exert upon the vacuum? As the result of experiments, the cylindrical, the conical and the conico-cylindrical shape of stack came to be applied. So, in order to learn the influence of each, we make a comparison.

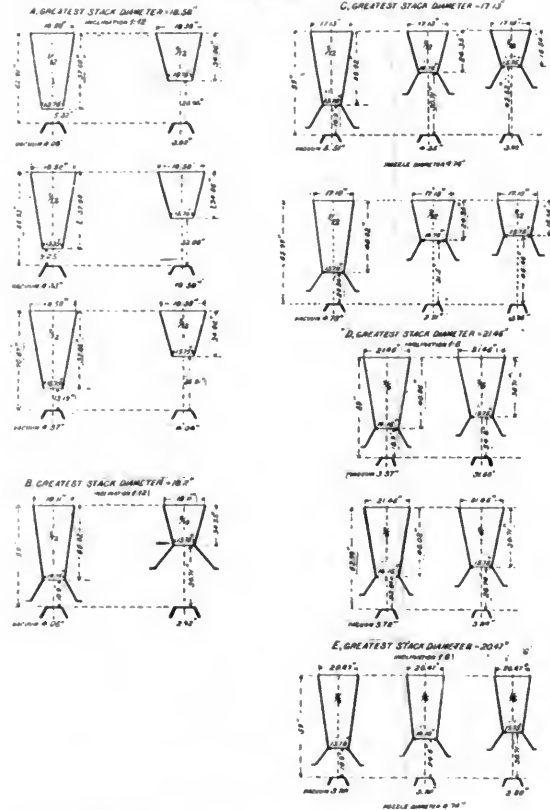
- 1, between the funnel-shaped and the waist-shaped stack;
- 2, between the full length and the stack shortened at the top, wherein the two stacks exactly corresponded at their upper ends, and were of a given length.

Fig. 43 shows two of these stacks having a total height of 4 feet 11 inches which for the last 3 feet 4.02 inches of their upper ends are exactly alike. The vacuums obtained with stacks of different diameters and inclinations, with nozzles of 3.94 inches and 4.74 inches in diameter, are shown grouped together in the following table XIX.

TABLE XIX.

		Inches.	Vacuums with	
			Tunnel-shaped stacks.	Stacks with waist.
Inclination $\frac{1}{2}$	$D = 21.42$	nozzle diameters =	3.94	2.48
	$d = 13.78$			
	$d_1 = 14.72$			
Inclination $\frac{1}{3}$	$D = 17.90$	nozzle diameters =	3.91	3.39
	$d = 13.78$			
	$d_1 = 14.25$			
Inclination $\frac{1}{4}$	$D = 19.87$	nozzle diameters =	3.94	2.58
	$d = 15.75$			
	$d_1 = 16.22$			

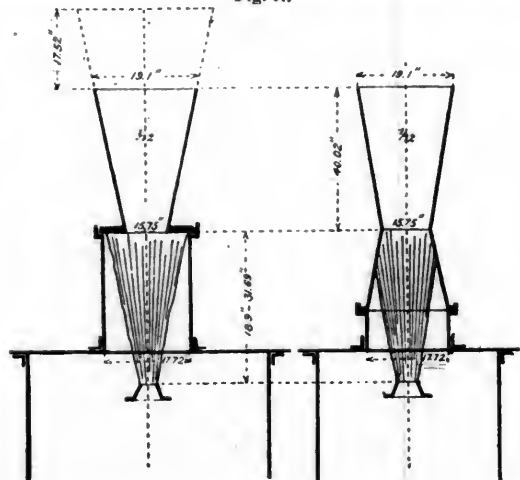
Fig. 41.



For greater nozzle distances than these shown in Fig. 43, there is a similar correspondence, as shown by the lines of the diagrams.

Another example is clearly shown in Plate III. Here a full length waist-shaped stack with an inclination of $\frac{1}{2}$ and with a minimum diameter of 15.75 inches is compared with a funnel-shaped stack of the same minimum diameter, but from which 17.52 inches have been taken from the upper end. Both stacks are, therefore, the same length from their point of smallest cross-section to the top. They should then, according to the foregoing, give practically the same values for the vacuums obtained with

Fig. 44.



them. If we now combine the corresponding co-ordinates of the funnel-shaped stacks from Plate IV. (abscissas 3 feet 0.42 inches to 4 feet 1.10 inches), with those of Plate III. (abscissas 1 foot 6.9 inches to 2 feet 10.65 inches) we obtain as the points of the curve those shown by the dotted curve given in connection therewith.

The latter lie, in all five cases, below each of the waist-stacks, but the actual difference is not really as great as one would be led to think from the diagrams. But we must consider that there were several observations that were known to have been erroneous, that there were many interruptions to the work, and that some slight inaccuracies in the reproduction of the curves have crept in. In figures the values for the abscissa of 18.9 inches with a nozzle diameter of 3.94 inches are, for funnel-shaped stacks, 2.72 inches; for waist shaped stacks 2.82 inches.

When the nozzle diameter is 4.33 inches these values become 3.05 inches and 3.17 inches. When the nozzle distance is about 27½ inches from the smallest portion of the stack, the difference, as shown in Plate III, is greater, though still insignificant. From this it appears to be certain that, with a nozzle distance of about 27½ inches, a continuous current of steam, like that shown in Section VIII., which deals with the "shape of the steam current," begins to fill the whole sectional area of a stack that has a diameter of 15.75 inches, and that, at a greater distance, it strikes against the foot of the stack; that is to say, with the funnel-shaped stacks it strikes directly against the ring at the bottom, while with those having a waist, it impinges against the sides of the flare at the bottom. Both cases are clearly shown in Fig. 44. In the first case there must naturally be a somewhat more vigorous impact and a greater contraction at the smallest cross-section than with the waist-shaped stack, as well as a corresponding $\frac{1}{2}$ the vacuum indicated.

[TO BE CONTINUED.]

Communications.

The Metric System.

Editor American Engineer, Car Builder and Railroad Journal:

In your April issue, page 59, I find an interesting article on the "metric system." It is true that the larger part of European governments have adopted that system, and in doing so have made progress from the confusion in weights and measures existing in former times. But now that we are intimate with all the peculiarities of the system, we are able to see its various faults, principally arising from the unfortunate choice of units. These units are scientifically derived, but not adapted to the daily work of many people. Their only advantage is in the use of the decimal division, but for the exigencies of practical trade these units are not adapted.

Furthermore, in the metric system only the factors of measure and weight are in good arithmetical connection, while the experience of modern times demonstrates that the factors of value and time should not stand aside; they are to be fellows of the closed ring—measure, weight, value and time. For all this, though being a condition of progress in the expansion of modern trade, there is no room in the metric system, and, as the world progresses, we see that the metric system is not at all to be the final one. If your country wants to take in hand the heavy work of changing your units for others, these ought to be of a real international character you want a system and units whose practical qualities are much superior to those of any system which has thus far been used anywhere, in order to be accepted for its advantages by other people. This also will be the shortest way to arrive at an international understanding about these things and not by substituting any defective system by another one.

I inclose a short sketch of an international system which might suffice for all scientific and practical purposes. WILHELM BOSSE, Vienna VII., Burggasse 2, Austria

[Herr Bosse urges, in his circular, that the four factors of dimension, weight, value and time should be based upon some system of the utmost simplicity that is practicable, and should also be connected with one another in a manner that is clear and devoid of complication. In order to accomplish this he starts with his measure of length. In this he would take as the unit the equatorial circumference of the earth and divide it into 1,000 geographical degrees, and then sub-divide each one of these degrees into 10 miles, so that a convenient measure of length would be obtained, and one which could readily be used as a basis of the measure of time. For a practical working dimension this

mile should be itself divided into 10,000 feet, two of which feet would be equal to the usual step. Further subdivisions would be on a decimal basis. For cubic capacity, the unit would be a cubic foot, divided into 100 parts. The size of the latter corresponds quite accurately with the ordinary wine measures used all over the world. The unit of weight is also based upon the cubic foot, and should be the weight of a cubic foot of water, and is only slightly heavier than the centner used up to the present time. The subdivisions to follow would naturally be into 100 pounds. For value, Herr Bosse assumes that the relative value of gold and silver to be as 20 to 1. On this basis he proposes an effective weight of $\frac{1}{100}$ pound of $\frac{9}{10}$ fine fine gold, whose value would be about 20 francs as a basis, and on the same hypothesis $\frac{1}{100}$ pound of $\frac{8}{10}$ fine silver would represent two francs. This is recommended as the international unit of value.—EDITOR.]

Discussing Rail Specifications.

At a recent Pittsburg meeting of the officers' association of the Pennsylvania Company, attended by representatives of the lines and branches west of Pittsburgh, the principal topic of discussion was the chemical composition of the steel rails used on the Pennsylvania system. While it was conceded that the character of the rails laid has shown some improvement in recent years, it was also brought out in the discussion that there had been more breakage than the management wanted to see in the past year. The drift of sentiment was toward a specification for lower phosphorus. No formal action was taken, and we are advised by an officer of the road that the matter is simply being investigated with a view to obtaining as much light as possible on the subject. It is not definitely determined, indeed, that any change from recent practice will be made.

The expressions at the Pittsburgh meeting, however, are in line with the new specifications for steel rails presented by Robert W. Hunt at the Atlanta meeting of the American Institute of Mining Engineers last October. Capt. Hunt made the point that whereas the Western mills had been allowed 0.11 per cent. phosphorus in their rails, and in some cases 0.12 per cent., it was now practicable, in view of the vast deposits of low phosphorus Mesabi ores, for these mills to bring the phosphorus in their rails below 0.09 per cent. The new specification which he presented, therefore, called for not to exceed 0.085 per cent. phosphorus, and silicon not below 0.10 per cent. The specified range in carbon was not below 0.43 per cent. and not over 0.51 per cent. for the 70-pound section; not less than 0.45 per cent. and not over 0.53 per cent. for the 75-pound section; not less than 0.48 per cent. nor over 0.56 per cent. for the 80-pound section; not less than 0.55 per cent. nor over 0.63 per cent. for the 90-pound section; not less than 0.62 per cent. nor over 0.70 per cent. for the 100-pound section.—Iron Trade Review.

The Limit of Elasticity.

In an interesting article in *Science Progress* on the "Mechanical Testing of Iron and Steel," Prof. Hudson Beare has the following to say on the limit of elasticity:

No term has given rise to more confusion in dealing with the strength of materials than this. One instance will suffice to show the kind of error produced by false notions as to its meaning: the well-known fact that by stressing a bar in tension beyond its yield point we raised its limit of elasticity in tension, was usually considered to represent the whole result of the action. We know, however, from the researches of Bauschinger that this is a very imperfect and misleading conclusion—a conclusion, too, which may have caused much of the difficulty in understanding some of the results obtained in the endurance tests of Wohler. Bauschinger's experiments, carried out with perhaps more exactitude than any previous experiments of this nature, lead us to conclude that there is for any given material a true natural limit of elasticity, understanding by that term the limit of the elastic condition according to Hooke's law, *ut tensio sic vis*. But this natural limit may be varied in all sorts of ways—by strains set up in the material during manufacture, by after working, or in a testing machine. Unless, therefore, we know the whole previous history of the bar we are testing, we are quite unable to say whether the limit obtained in our test is a natural one, or whether it is some artificial one produced by some treatment the bar has undergone. In one form this fact

was appreciated by all those interested in the question of testing. It was well known, for example, that cold rolling greatly raises the limit. Two bars rolled from the same ingot would give very different values for this factor, the one with the smaller cross-sectional area—and, therefore, during the last stages of manufacture rolled while partially cold—would show a much higher apparent limit. But it was not, at any rate, generally understood that such effects were only particular cases of a much more general law. This fact at once disposes of the talk often indulged in during discussions on this subject as to the value of high elastic limits when they are determined simply from a static tensile test; and the importance of the question is at once realized when we consider that these so-called higher values are made the basis of a claim for higher working stresses, even for cases where the loads are alternating tension and compression. It is to be hoped, therefore, that this question of the determination of the natural limits of elasticity of different qualities of iron and steel will be undertaken as a research work by some competent observers having the requisite delicate measuring apparatus at their disposal. Such a research, if carefully carried through, would settle many important points of the uttermost practical value, and would, at the same time, confirm experiments which, from their far-reaching consequences, and from the fact that the deductions from them depend on extremely small differences in measurements themselves very minute, much need confirmation. Carried out in a systematic manner, careful chemical analysis being made of the material tested, we should obtain data to make it possible to deduce the relations existing between the values of the natural limits, and the proportions of the various constituents of other elements present in iron or steel, and probably be able to ascertain definitely the best proportions for a material required for some given purpose. It would also enable us to settle in a much more rational manner the working stresses which could be allowed in any given case; this, a matter of the utmost consequence in the case of parts of machines or structures subjected to alternations of stresses, is equally of importance where there are only variation of stresses or even only long continued static loads, for we are still without information as to the changes which may go on in the value of the limit under these conditions. That a steady change in the opinion of engineers in regard to this question of working stress has been in progress for the past few years is undoubted, but at present we are still groping more or less in the dark, because, though there is a mass of rapidly accumulating data, it at present seems largely to be only capable of being used in a more or less empirical fashion, and still to be in need of some rational explanation. The researches of the Committee of the Institution of Mechanical Engineers on "Alloys" has no doubt done something to shift the question into a clearer light, but the field open for research is still very wide.

Kindling Locomotive Fires on the Norfolk & Western Railroad.

At a recent meeting of the Southern & Southwestern Railway Club Mr. R. P. C. Sanderson, of the Norfolk & Western Railroad made the following statement in relation to locomotive fire, kindlers:

It is only recently that much has been heard about kindling fires of locomotives by the use of oils instead of cord wood or waste wood from the car shops, and much mystery and many patents have been in evidence since then.

To ascertain just exactly how much benefit and economy was to be achieved by discarding wood for kindling fires and introducing the use of oil, experimental apparatuses of different kinds were prepared at some of the shops of the Norfolk & Western Railroad, and after a few months of experimental use, with varying success, it was found that the economy by the use of oil as compared with firewood was very great, and pressure was then brought to bear on each of the shops to see how little oil could be used for this purpose.

In the first devices experimented with, crude or fuel oil was employed, as it was thought that the greater calorific properties of crude were decidedly beneficial. As it was a great inconvenience to carry the small quantities of this special oil in stock at points where cheap black oil used for lubricating cars was carried in storage tanks, the use of crude oil or fuel oil was soon abandoned and lubricating oil used, with a small addition of kerosene to make it more inflammable. Subsequently it was found that the addition of kerosene was quite unnecessary and that the lubricating oil was sufficient in itself.

It was then found that by establishing some rivalry between the different shops the quantity of oil used could be steadily reduced until the cost per engine for a month's firing-up had dropped to one and one-fifth cents per engine. Subsequent to this it was further found by one of our master mechanics that the oil was entirely unnecessary, and that by heaping up lump coal in a mound a short distance from the inside of the fire door and by throwing the usual handful of greasy waste (discarded by the wipers) on the face of this coal pile, setting fire to this waste, and then directing a jet of compressed air directly on this small handful of burning waste, the flame from it can be driven right into the coal pile, and that in the course of four or five minutes, or possibly a little longer, according to the condition of the coal and the pressure of the air used, the mound or heap of coal can be brought to a good red heat ready for spreading over the grate bars without the use of any oil whatever. This plan has been found to be successful with the Pocahontas coal, Clinch Valley coals, and Thacker and semi-split coals used on the Norfolk & Western Railroad, which vary widely in their nature, and it is believed that this same plan can be followed with any coal that is not too hard or slow burning in its composition.

I do not wish to say that we do not now use any oil for firing up, because we have found that with the use of a little oil in with the compressed air, it will hurry up matters a little in cases of emergency.

The majority of the engines fired which are referred to have large fireboxes 10 feet or more in length, and at most of the engine houses the boilers are filled with hot water, and in this way considerable economy in time in firing up and getting engines ready for service has been accomplished without any injury to the boilers.

Where nothing but air is used to ignite the coal, it will be found ordinarily that it does not pay to handle the scrap wood from the car repair tracks or the old ties or bridge lumber, as the cost of cutting it up and handling it is greater than the small amount of coal consumed in compressing the air, and to get rid of this old material it is found to be more economical to sell it as firewood to the employees and public at a small price, or to burn it up in heaps where it lies, if it cannot be got rid of in any other way.

We take from the discussion of Mr. Sanderson's statement the following:

Mr. GENTRY—Mr. Sanderson does not say how much coal is used. I don't suppose much of it is consumed. I take it that it don't take very much more coal than where wood is used. I saw one experiment made at Alexandria by Mr. C. F. Thomas, and it didn't strike me that very much coal was consumed during the process of ignition.

Mr. HUDSON—My experience has been that it takes very little more coal to kindle with oil and coal than it does with wood and coal. I find that fires can be kindled with a great deal of economy without using any oil at all by simply putting in a small quantity of waste, and using the steam blower on the engine. We fire about as many engines without oil as with oil, and there is no injury to the flues or sheets. There is practically no difference in time with or without oil.

T. W. GENTRY—It was not necessary for the parties I referred to to go to any expense in the way of a new plant. They utilized what they had at hand, which was an old boiler, to fill the engines with hot water. Anybody who has an air pump can utilize it. It is not much of an item with a few engines. The experiment I have seen was in a large engine house, where everything was at hand. They just used the blower and the dirty waste.


Mr. ANDERSON—I remember making one experiment in kindling fires with dirty waste, in which it took within a few pounds of 500 pounds of coal to get 65 or 70 pounds of steam. I did not use any wood, and we got steam up in about 55 minutes. I have not used any wood for over two years; we kindle all our fires with waste that has been used to wipe with.

Wegener's Apparatus for Burning Powdered Fuel.

The accompanying engraving, reproduced from the *Engineer*, illustrates a new form of apparatus designed by Herr Wegener for burning finely pulverized coal, and burning it in such a way that the quantity is automatically varied with the quantity of air admitted for supporting combustion. The apparatus has been in use some time in Europe, and is now in use in the works of Messrs. Bryan Donkin and Co., London, England.

Our engraving shows the apparatus in detail as applicable to any boiler. The small sacks of powdered coal, weighing about 50 pounds

Crosby Steam Gage and Valve Company.

This company, as most of our readers know, is a Boston "institution," with its works in Charlestown, of Bunker Hill fame. Recently while enjoying a visit to the Hub the pleasure was increased by an inspection of the works referred to, the expedition being personally conducted by Mr. George H. Eager, the treasurer of the company. The works consist of a main building 451x77 ft. and four stories high, which is thoroughly equipped with the most approved machinery for manufacturing the appliances which are specialties of the company. As its name indicates, the principal products are steam-gages and safety-valves. Of the former they make several different kinds. Among these are the Bourden gage, with an ordinary C-shaped pressure tube, the lower end of which is fixed and the upper connected to the index mechanism. In another form the tube is placed thus, , and held securely in the middle, the two ends being free and attached to a T-shaped lever which operates the index. With these gages a system is used to keep the gage tube filled with water and thus keep it cool. A third form is what they call their "thermostatic water back gage," in which two tubes are placed thus () with their lower ends attached to a chamber which is filled with water or other liquid, and answers the purpose of an ordinary siphon. This chamber is placed between the two tubes. The upper ends of the tubes are connected to a T lever which forms part of the index mechanism. It is found however, in practice that after the tubes have been tested and adjusted to a certain movement under pressure in the ordinary temperature, and then give correct indication of pressure, that when the tubes are heated in use to a higher temperature they are lengthened thereby to such an extent that their free ends will then move through a larger arc than they did when they were tested, and thus a greater pressure than actually exists in the boiler is indicated on the dial. In the gage which is here described, the long arm of the T lever is made of brass and steel brazed together, which forms a "thermal bar," and the unequal expansion of the two metals compensates for the expansion of the tubes.

These gages, the makers say, are especially adapted for locomotives and for other boilers in which the high pressures now in vogue are used.

The company makes gages for a great variety of purposes, including hydraulic, vacuum water, ammonia, air, gas and pyrometer gages. These are all tested with great care and with apparatus specially constructed for the purpose, with which the testing-room is equipped. The utmost care is exercised, and the greatest precision is aimed at, in testing gages, and any defect is certain to be detected before they leave the company's hands.

Another important branch of the Crosby Company is the manufacture of safety valves. These are of the "pop" type, and are made especially for locomotives. A peculiarity is a flat annular seat, which the company claim can be kept tight easier and longer than any other form. The valves are encased and some types are provided with perforated mufflers to deaden the noise. What is called the Meady valve and the Crosby-Meady valve is made for locomotive and also stationary and marine boilers. A variety of forms and patterns are made adapted to various classes of boilers.

One of the phenomena of modern engineering is the greatly increased use of indicators, as a means of diagnosing the condition and operation of the organs of steam engines. Their use has been greatly extended, no doubt, by the general diffusion of technical education. The result has been that of late years there has been a great demand for reliable indicators, and supplying these has become an important branch of the Crosby Company's business. The introduction of high-speed engines of late years has created a special demand for improved indicators, which the Crosby Company have made great efforts to supply. The greatly increased speed of steam engines has made extreme lightness, a nice adjustment of moving parts and the finest workmanship indispensable in an indicator to make it reliable. To meet these requirements the

utmost refinements of good workmanship are essential. The Crosby shops have therefore been equipped with the very best machinery and appliances to make these instruments of precision, and an elaborate system of manufacturing the parts in duplicate and to gages has been organized, so as to insure the required accuracy. When the instruments are assembled they then go to the testing-room, which is equipped with a very elaborate testing apparatus for subjecting the whole mechanism to a thorough trial before it is pronounced perfect and allowed to leave the hands of the makers.

The construction and the operation of the testing apparatus could not be explained so as to be understood without illustrations, and for them we have not space, nor is there time to prepare them. It must suffice now to say that every indicator made here is thoroughly tested in every way, so as to make it certain that it is entirely reliable in all respects.

The company also manufacture Amsler's Polar Planimeter, that mechanical puzzle, the action of which few of us old chaps, and probably not many of the younger ones, clearly understand.

Locomotive counters, relief valves, pressure-gage testers, spring-seat globe and angle valves, steam whistles, bell-chime whistles—of which we saw some specimens for Sound steamers with bells 12 x 24 inches—organ whistles for steam launches, etc.; whistle valves, blow-off valves, water-gage glass tubes and columns, water-gage fixtures, etc., etc., are all articles that are made in these works, which are so well equipped in all departments.

Test of a Combine Safety Water Tube Boiler.

A test was recently made of one of these boilers at the Marietta, Pa., Electric Light, Heat and Power Company's station to determine its capacity. It was rated at 125 horse-power, based on an evaporation of 30 pounds of water per hour from a feed water temperature of 100 degrees F. into steam at 70 pounds gage pressure. The test was made by Mr. Jay M. Whitham, Mechanical Engineer of Philadelphia, with the co-operation of Mr. W. Barnet Le Van as the representative of the light, heat and power company. The total heating surface of boiler was 1,100 square feet, the grate area 21.875 square feet. The test was continued for 8 hours and 30 minutes with the following results:

Water evaporated from and at 212 degrees F. per pound of dry coal.....	9.346 pounds.
Water evaporated from and at 212 degrees F. per pound of combustible.....	10.52 pounds.
Average boiler horse-power actually developed, by basis of 30 pounds per hour from 100 degrees F. at 70 pounds pressure.....	161.4
Rated boiler horse-power.....	125
Horse-power developed above rating.....	29.1 per cent.
Pounds of dry coal burned per hour per boiler horse-power developed.....	3.69
Pounds of wet coal burned per hour per boiler horse-power developed.....	3.76

A Locomotive-Building Plant for Russia.

A firm of American capitalists, to be known as the Russian-American Manufacturing Company, has been incorporated, with headquarters at present in Philadelphia, for the purpose of establishing extensive locomotive works at Nijni-Novgorod, Russia. The firm of Edmund Smith & Company, of Philadelphia, are interested in the project and Mr. W. F. Dixon, formerly of the Rogers Locomotive Works, has visited Russia to look over the site and prepare plans for the shops. The plant is to have a capacity of 200 locomotives per year and contracts for \$500,000 of machinery have already been placed with American tool builders. Among those who have received large orders are Bement, Miles & Company, Wm. Sellers & Company, Newton Machine Tool Works and Pedrick & Ayer Company, all of Philadelphia; Hilles & Jones and Betts Machine Company, Wilmington, Del.; the Niles Tool Works, Hamilton, O.; the Morgan Engineering Company, Alliance, O., and Greenlee Bros., Chicago.

The plant is to be built in connection with the Sermova Works, an extensive establishment in Nijni-Novgorod, manufacturing cars, steamboats, steam boilers, etc., and employing 5,000 men. Mr. Dixon will have entire charge of the locomotive works, which will be controlled jointly by the Russian and American companies. The locomotive plant will employ 1,000 men. It is understood that the Czar has encouraged the enterprise.

(Established 1832.)

AMERICAN ENGINEER CAR BUILDER AND RAILROAD JOURNAL

27TH YEAR.

65TH YEAR.

PUBLISHED MONTHLY

BY

R. M. VAN ARSDALE,

MORSE BUILDING.....NEW YORK.

M. N. FORNEY, } Editors.
W. H. MARSHALL, }

R. G. CHASE, 705 Western Union Building, Chicago.

JULY, 1896.

Subscription.—\$2.00 a year for the United States and Canada; \$2.50 a year to Foreign Countries embraced in the Universal Postal Union.

EDITORIAL ANNOUNCEMENTS.

Advertisements.—Nothing will be inserted in this journal for pay, EXCEPT IN THE ADVERTISING PAGES. The reading pages will contain only such matter as we consider of interest to our readers.

Special Notice.—As the AMERICAN ENGINEER, CAR BUILDER AND RAILROAD JOURNAL is printed and ready for mailing on the last day of the month, correspondence, advertisements, etc., intended for insertion must be received not later than the 25th day of each month.

Contributions.—Articles relating to railway rolling stock construction and management and kindred topics, by those who are practically acquainted with these subjects, are specially desired. Also early notices of official changes, and additions of new equipment for the road or the shop, by purchase or construction.

To Subscribers.—The AMERICAN ENGINEER, CAR BUILDER AND RAILROAD JOURNAL is mailed regularly to every subscriber each month. Any subscriber who fails to receive his paper ought at once to notify the postmaster at the office of delivery, and in case the paper is not then obtained this office should be notified, so that the missing paper may be supplied. When a subscriber changes his address he ought to notify this office at once, so that the paper may be sent to the proper destination.

The paper may be obtained and subscriptions for it sent to the following agencies: Chicago, Post Office News Co., 217 Dearborn Street. London, Eng., Sampson Low, Marston & Co., Limited St. Dunstan's House, Fetter Lane, E. C.

CONTENTS.

ILLUSTRATED ARTICLES:	Page.	EDITORIALS:	Page.
The Most Advantageous Dimension for Locomotive Exhaust Pipes and Smoke Stacks	132	Formation of Smoke in Boiler Plants.....	143
Wegener's Apparatus for Burning Powdered Coal.....	138	Shop Training of Apprentices.....	143
Dynamometer for Back End of Tender.....	140	Reduced Lead for Locomotives.....	143
Doherty Combined Vise and Winch.....	148	Counterbalancing Locomotives.....	144
Niagara Spray Ejector for Urinals.....	148	The Conventions.....	144
Dickerman Buffing Lathe.....	149	MISCELLANEOUS:	
A New Locomotive Boiler Covering.....	149	Proceedings of the Master Car Builders' Association.....	127
Improved Punching Press.....	149	Proceedings of the Master Mechanics' Association.....	130
Q. & C. Hoyt Flush Car Door.....	150	The Metric System (Communication).....	137
Star Pipe Wrench.....	150	Rail Specifications.....	137
Reports Presented to the Master Mechanics' Association.....	153	Limit of Elasticity.....	137
Reports Presented to the Master Car Builders' Association.....	158	Kindling Locomotive Fires.....	138
EDITORIALS:		Crosby Steam Gage & Valve Company.....	141
Topical Discussions at the Conventions.....	112	Test of Steam Boilers.....	141
The New Interchange.....	142	Russian Locomotive Works.....	141
The Gould-Trojan Coupler Decision.....	142	Notes.....	145
Pooling Engines.....	142	Personal.....	146
		Equipment Notes.....	147
		Manufacturing Notes.....	150
		Book Notes.....	151
		Our Directory.....	151
		Exhibits at the Conventions.....	151
		Souvenirs at the Conventions.....	153

The great amount of space required to properly report the proceedings of the conventions held in June has excluded from our pages this month much valuable material, among other articles laid over being the second one of the series on the Altoona shops of the Pennsylvania Railroad. This will appear next month.

The topical discussions introduced at the convention of the Master Car Builders' Convention last month were a great success. By having each subject introduced by members who had prepared brief and concise arguments or statements, the discussions were immediately directed upon the essentials of the topic, with the result that the 10 minutes allotted to each subject was usually sufficient to bring out all valuable information in the possession of the members. Preparation of that kind is the secret of topical discussion, and it is probable that the lack of that preparation has had its effect in almost wholly banishing topical discussions from the meetings of the Master Mechanics. The great number of reports presented and the time required for their consideration have also had their effect in eliminating these discussions from the latter body.

The new interchange has won and has received the unanimous approval of the Master Car Builders. No voting by cars was required this year; on the contrary, there was not only an overwhelming sentiment in favor of the new interchange, but an evident desire on the part of the convention to take the entire new code as it came from the Arbitration Committee without discussion or change. Such faith in the committee and its work is justifiable, and we are inclined to think that a similar treatment of its reports each year would not only save much time for the convention, but would result in a better and more consistent code. The changes made on the floor of the convention are apt to be found contradictory or inconsistent with other paragraphs from the simple fact that one cannot at such times keep in mind all the various sections of the code.

By the decision of Judge Cox, of the Circuit Court of the Northern District of New York, in the suit of the Gould Coupler Company against Pratt & Litchworth, rendered last November, it was decided that any knuckle-opening device that both automatically opened a knuckle and held it open was an infringement on the Browning patent owned by the Gould Coupler Company. If a device performs either one of these functions and not both it is not an infringement. A decision on an appeal from a preliminary injunction by Judge Lacombe, of the United States Circuit Court of Appeals, rendered May 27, defines the limitations of the term automatic, and decides that a device which does not act independently of the will of the operator and without his aid when the lock is raised, but on the other hand requires a distinct and separate movement on the part of the operator to swing the knuckle open, is not automatic, and is not covered by that term in the claim of the Browning patent. The case appears to be far from being settled, however, as the Gould Coupler Company announce that they will proceed with the case as though no injunction had been asked for.

In a discussion on the pooling of engines at the April meeting of the Western Railway Club, an apparent diversity of opinion existed. We say apparent, for on close reading it seems that members had different definitions of pooling in mind during the discussion. If pooling be taken to mean that method of running engines in which no crew or sets of crews are assigned to any one engine, and no crew is responsible for an engine, then it may be said that there were few friends of pooling present. At the same time it is realized that the highest standards of operation require that engines shall make a large monthly mileage—much larger than can ordinarily be obtained by assigning a single crew to each engine. Hence the practice of assigning two crews to one engine, three to two, five to three, or in a similar way grouping engines and men into what has been called "small pools," instead of one general pool, is gaining in favor, and, we think, rightly so. Pooling, in the broad sense of that term, has generally been found to lead to increased cost of

repairs and of fuel, due partly to the lack of interest on the part of the men in the engines they run, and partly through the lack of that familiarity with an engine and its peculiarities which is obtained by long association with it. By so assigning the crews to engines that the motive power will be kept in motion as much of the time as is compatible with proper care and maintenance, and each engine has at least one crew that is responsible for its condition, the large mileage can usually be obtained without the disadvantages associated with a general pool. But lengths of divisions, character of traffic and other local conditions must be taken into account in the decision of any individual case.

Those who believe that the formation of dense smoke in steam plants can be abated and the smoke nuisance in our cities and towns greatly reduced, and who at the same time believe that the formation of smoke cannot be wholly prevented without a loss in the efficiency of the boilers, will doubtless find support for their views in the results of a peculiar competitive test recently carried out under the auspices of the Sheffield Smoke Abatement Society. Five competing firemen were each allowed to fire a Lancashire boiler for seven consecutive hours and the prize was awarded to fireman who evaporated the greatest quantity of water with the least amount of fuel and with the least quantity of smoke. The boiler was 28 feet long and 8 feet in diameter, the two flues being 3 feet 3 inches in diameter at the front, tapering down to 2 feet 10 inches at the back. The grates measured 6 feet by 3 feet 3 inches, giving a total grate area of 39 square feet. The grate bars had $\frac{1}{2}$ -inch spaces. The working pressure was 100 pounds per square inch. The coal used was "washed hard nut" and was of uniform size and very clean. The best result as to evaporation was equivalent to 9.08 pounds of water from and at 212 degrees Fahr. per pound of coal, but the fireman with this record had, on the other hand, the worst showing as to smoke. The first prize went to a fireman who secured an equivalent evaporation of 7.95 pounds of steam from and at 212 degrees Fahr., while only producing dense smoke for six minutes out of the whole seven hours occupied by the trial. This record was beaten by two other competitors, one of whom produced dense smoke for two minutes only and was responsible for an equivalent evaporation of 8.07 pounds per pound of coal, but he produced much more "faint" and medium smoke than the first prize winner, and so failed to head the list. The coal burnt per square foot of grate surface per hour ranged from 23 pounds to 28.1 pounds. Thus we see that the man who produced the least smoke was beaten by three out of four of his competitors on evaporation. While this may go to show that an entire absence of smoke from the average boiler may mean a loss in efficiency, it must be borne in mind that all of the men produced amounts of smoke infinitesimal in comparison with the average fireman of to-day, and that the production of more than formed in the worst of the five trials would have doubtless been accompanied by a falling off in the evaporation. No argument can therefore be drawn against the improvement in the average of present practice so urgently needed.

The problem of providing competent and skillful workmen in the various departments of manufacturing establishments and railroad shops is one that is not easily solved. It is believed, however, that the committee which reported on the subject to the Master Mechanics' Association last month went wide of the mark. We do not intend to take up the matter at any length, at this time, but we would submit for consideration the opinion that the most important part of the problem lies not so much in the opportunity to be given the technical graduate, or the technical education of the apprentice, important as these are, but rather in the shop training of those who by their talents or inclinations are destined to remain in the shop either as workmen or foremen. The technical graduate will generally find means to get as much shop training as he needs, and as he usually has ambitions and a well-defined purpose, his case is a special one capable of special treatment. The well-educated apprentice who is bound to make his trade a stepping-stone to something higher is undoubtedly deserving of encouragement and any help and coun-

sel given him in the shop or out of it will prove a good investment for the individual or firm that tenders it. Nevertheless, the great class demanding consideration on the part of employers we believe to be the average apprentice who intends to remain in the shop and who will end his apprenticeship according to the treatment he receives, either as a skillful and intelligent workman, loyal, independent and manly, and of great value to his employers, or as a mechanic capable of doing few things well, perceiving more or less clearly the injustice of the treatment accorded him, and ready to join the ranks of those who wage the war between capital and labor. The improvement in the training of this class of apprentices, if their presence in the shops is to be continued, must begin with the shop training itself, before it takes up their technical education. It is their right. They go into the shop to work for a certain number of years for a compensation which is to be paid partly in cash but mostly in knowledge. If the opportunity of acquiring the latter has been denied them, they have not been fully paid, even if the cash part of the pay has been forthcoming regularly. And if the employer who keeps a boy on a bolt-cutter or a drill-press or doing the lower grades of work about a shop, until most of his time has been spent, considers he is just in his treatment of the boy, or has put money in his own pocket, he is mistaken. He has not only been unfair to the apprentice, but he has actually failed to benefit by his services as much as he might. This class of apprentices who learn a trade and work at it for life, are the most numerous class, and employers are interested in improving their facilities and opportunities for acquiring knowledge.

REDUCED LEAD FOR LOCOMOTIVES.

The mechanical officials of a number of large railroads in the West have recently given much attention to the effect of various amounts of lead upon the steam distribution and economical performance of locomotives. The time-honored rule in valve-setting in many parts of the country has been to give the engine $\frac{1}{4}$ or $\frac{1}{2}$ lead in full gear, and trust to luck for good results in the working cut-off. With some valve gears this method of setting gives a lead of about one-quarter inch in the six-inch cut-off, while with others it may give as much as three-eighths of an inch. The latter condition is almost certain to produce a bad riding engine—one that is uncomfortable for the men and hard on its machinery, besides being less efficient.

The few who have had the hardihood to disregard that aged and much respected rule by which a given amount of lead is carefully provided at full stroke where it is of no account, and allowed to be settled by mere chance at cut-offs where it plays an important part in the working of the engine, have adopted various methods of obtaining a desirable lead at the cut-offs where the engine does most of its work. One of these methods is to set the valves blind in full gear by an amount sufficient to give the proper lead at the working cut-off. This sometimes results in the valves being nearly one-quarter inch blind in full gear to get, say, three-sixteenths lead at six inch cut-off. Contrary to what some persons would expect, a passenger engine with the valves so set will work admirably. Another method for accomplishing the same result is to set the valves about line and line in full gear forward and to move the backing-up eccentrics until the lead at the working cut-off is reduced to the desired figure. This method is all right for a passenger engine, but may not be desirable on a freight engine that is called upon to back heavy trains. Evidently a combination of the two methods mentioned might also be employed. Each of the methods has had its advocates, but the experience of the roads referred to teaches two lessons most clearly: First, that the lead on fast passenger engines, whose valves are set with lead in full gear for forward and backward motion, is too great in early cut-offs; and, second, that it makes comparatively little difference in the working of a road engine how the reduction of lead is effected, providing, of course, that the valves are not set in a manner that will place the engine at a disadvantage in occasional switching operations or other special duties. The essential condition seems to be that the lead should be just sufficient to

admit the right amount of steam to obtain boiler pressure in the cylinder at the end of the stroke under the average conditions of speed and cut-off. To provide more lead than this is to produce a loop on the diagram, an undue strain on the running gear, greater friction in the engine when passing the dead centers, a poorer steam admission line with its consequent loss of power, and a bad riding engine. Having determined the right amount of lead to overcome these troubles, experience shows that there is but little choice between the methods of obtaining it, as the advantages which any one method may appear to have in delaying the exhaust opening or closure, or affecting other points in the steam distribution, are small compared with the gain from proper lead.

The gain in power from the reduction of the lead is remarkable. It has been found to make passenger engines smart and capable of making up time with trains that under the old method of setting they could hardly haul on schedule time, and has enabled freight engines to handle satisfactorily ten per cent. heavier trains. It is needless to add that where Allen valves are used the lead should be cut down to an amount sufficient to produce exactly the same influx of steam at the end of the stroke as with the plain valve. This done, the greatest advantage of the Allen valve will be realized. This seems to be the gist of the matter and the conclusions certainly appeal to the sound sense of those who are familiar with the problems associated with the proper distribution of steam in locomotives.

COUNTERBALANCING LOCOMOTIVES.

The report on counterbalancing locomotives presented to the Master Mechanics' Association last month is the best contribution to the subject that has appeared for a long time. It is brief and to the point, and the committee in recommending that the weight of reciprocating parts left unbalanced should bear a definite ratio to the total weight of the engine rather than to the weight of the reciprocating parts themselves, undoubtedly formulated the only correct rule. Experience may show that the ratio should vary somewhat with the length of the engines, the wheel bases and the weight on the forward trucks, but the principle on which the rule is based will stand.

The discussion of the report brought out the vicious character of some of the methods of counterbalancing at present in vogue. The worst of these is that of the unequal distribution among the drivers of the counterbalance for the reciprocating parts. Sometimes this is done so that the same wheel pattern can be used in eight-wheeled engines, and in consolidation, mogul or ten-wheeled engines, it is often done because it is impossible to put the proper amount of counterbalance in the main wheels. Now, the old rules of balancing from 60 to 90 or even 100 per cent. of the reciprocating parts and equally distributing that balance among the drivers is not as scientifically correct as the rule proposed by the committee, but we venture the assertion that no case of bent rails or other damage to track ever occurred where such a rule was followed. The damage to track has always resulted from a shortage of counterbalance in one pair of wheels being made up by an excess in others. There is no excuse for such bad practices. In eight-wheeled engines it is always possible to put the correct amount of counterweight in each wheel and the same is true of mogul and ten-wheeled engines whose drivers are large enough for fast service.

In freight engines of these or the consolidation types, it may be impossible to get the required amount in the main wheels, but it is much better practice to let the total amount of counterbalance for the reciprocating parts fall short of the amount required by rule than to make up the shortage by placing excessive weights on the other wheels. It is true that a small amount of the shortage might be thus made up with safety in some cases, but the practice is a dangerous one unless the assignment of the weights to the various wheels is made by one familiar with the whole problem. The rule proposed by the committee will tend to correct this evil, as freight engines of the types mentioned are usually quite heavy, and a larger portion of the reciprocating parts can be left unbalanced, thus making it possible in practice to get nearer to the total counterbalance required in the main wheels.

But master mechanics will still meet with special cases, and then the caution to be heeded, if one would prevent damage to track, is to avoid an excess of counterweight in any one pair of wheels.

THE CONVENTIONS.

The Car Builders' and Master Mechanics' annual conventions have now become established "institutions" in this country and those who are connected directly and indirectly with the two departments of railroad operation, which are represented at those meetings, would feel that the year would be as incomplete without them as it would be if Fourth of July and Christmas were omitted. The attendance this year was larger than ever, and it may readily be understood that those who have been coming to these meetings for five, ten, twenty or twenty-five years have made many pleasant acquaintances in that time, and that the annual assemblages have not only their technical and professional interest, but that they are social reunions, around which many pleasant reminiscences cling, and which recall some sad recollections. The people who go there have, of course, changed very much during the period that has intervened since the associations were first organized. Some of us who have been in attendance for a quarter of a century are compelled to admit

"That we, we are the old men now;
Our blood is faint and chill;
We cannot leap the mighty brook,
Or climb the breakneck hill.
We mander down the shortest cuts;
We rest on stick or stile,
And the young men, half ashamed to laugh,
Yet pass us with a smile."

Some one has said that "young men think old men are fools, but old men know young men to be so." The Germans have a maxim that the "old effect more by counsel than the young by action," and another proverb is to the effect that "experience without learning is better than learning without experience," and Dr. Johnson said that "experience is the great test of truth, and is perpetually contradicting the theories of men." Nevertheless it must be admitted, in the words of an Eastern adage, that "a prudent youth is superior to a stupid old man," and taken all together that the young chaps have the best of us.

These reflections are suggested somewhat by the character of the proceedings of the meetings. A comparison of the reports presented in Saratoga with those made, say, 10 or 20 years ago, will indicate that a new element has been introduced into the association. That element is the graduate of the technical school. He has now assumed control and is likely to keep it. It has been said of youth that it is a defect which cures itself, and the same is true of the inexperience with which the graduates of technical schools were charged not long ago. If they are appointed and remain in responsible places, they are certain to get experience, and will thus be obliged to submit themselves to the contradictory teaching which Dr. Johnson referred to. In view of this, the old chaps can temporarily tolerate such crudities as may sometimes float on the surface, knowing full well, that the authors of them will in time learn, what some of us have found out by hard knocks, which is that those things which are not quite sure are very uncertain.

There are two considerations which should never be lost sight of by committees in preparing reports for these associations. One of these is that the majority of the members are and probably always will be men whose schooling has been in the shop, and who are erudite in experience, but not in scientific knowledge, and who are more skillful in the use of mechanics' tools than in mathematical formulæ. As this class forms the majority of the members they should not be ignored, as they are when reports contain much matter which is incomprehensible to the practical men. A report should be adapted to its purpose, and at least part of it should be understandable by those to whom it is read and for whose edification it is intended.

The other part which is often lost sight of by the authors of reports is the limited time and attention which can be given to them. The Car Builders hold two sessions of three hours each for three

successive days, and the Master Mechanics one session of five hours, so that at most they are only in session from fifteen to eighteen hours, a considerable portion of which time is devoted to routine business. The Master Mechanics this year had reports on ten different subjects, and the Master Car Builders on twelve. It is, therefore, almost impossible to devote an average of as much as an hour to the reading and discussion of each of the reports.

Then, too, there is the fact so seldom realized that it is extremely difficult to keep the attention of an audience on anything which is read for more than 20 minutes, and to do that it must be interesting and easily comprehended and followed. The task which a committee must therefore assume is the preparation of a report which will not consume more than 20 minutes in the reading of it, and can easily be followed and understood by those who hear it. Just to the extent that the reading exceeds that limit of time, and is difficult of comprehension the work of the committee fails in what should be the purpose of their report. If any highly scientific and abstruse investigation or dissertations are essential to the deductions or the conclusions in the report, these should be relegated to appendices to be printed with it but not read.

The reports this year, it is thought, were quite up to the average in interest and value. Some of them are rather tough reading, as for example the one on "Exhaust Pipes," which embraces two distinct investigations, the reports of which are not as lucid as they might be. The report on "Slide Valves" opened an animated discussion and some of the conclusions of the committee were questioned, and on some points the authors were finally driven to the admission that they were not quite sure of their ground. It is to be regretted that the funds of the association would not permit of more complete illustrations of this report, which, if not entirely sound in some of its deductions, was at least very suggestive.

The metrical system of measurement, or rather its compulsory adoption, was also up for consideration, but the measure met with little favor. The advocates of this movement should read Herbert Spencer's article on it, which was published in the June number of Appleton's Popular Science Monthly.

The declination of Mr. Sinclair of the office of Secretary of the Master Mechanics' Association left a vacancy which was filled by the appointment of Mr. Cloud to that office, who thus becomes Secretary of both associations. This, it is hoped by some, may lead to their consolidation.

The time which must now be given by any one who wishes to attend both meetings is greater than most of them who come to them can afford. The sessions at Saratoga began on Tuesday morning and ended at noon on Wednesday of the following week, and changes made in the by-laws will add two days to this period for next year. The Master Mechanics met on Monday morning of the second week. If they should hold their meetings on Monday, Tuesday and Wednesday there seems to be no reason why the Car Builders could not hold theirs on Thursday, Friday and Saturday following, which would compress the whole session into one week, which seems very desirable.

The general verdict of all was that there was no place like Saratoga for these meetings. The hotels give unlimited accommodation to those who attend, and there need be no dissatisfaction on that account. The balmy atmosphere and the aperitive waters seem to incline the sojourners to deliberation, and open their minds to the reception of knowledge and new ideas.

Colonel Clement, the proprietor of Congress Hall, was again entitled to the thanks of his guests, who were entertained by him with the same hospitality that he has dispensed on previous occasions, and many left his hostelry feeling that their thanks were still due to the host after their bills were paid.

NOTES.

The Pullman car service on the Omaha line of the Northwestern Railroad has been displaced by the Wagner car service, through a contract signed about six weeks ago. The Pullman Company is said to have made a hard fight to retain the business; but the Vanderbilt interests in the Northwestern road, which

controls the Omaha line, were too powerful to be overcome, and, as a result, the Pullman cars will have to go. This will increase the mileage served by the Wagner Palace Car Company by some 1,500 miles.

Locomotive engineers and firemen in England are urging the adoption of American cabs on English engines. Several meetings of the men have been held at the large railroad centers in order to bring before the companies the adoption of this reform. A committee appointed by the men have examined the cabs on the North Eastern Railway, and an engineer has returned from a visit to this country for the purpose of reporting on our practice, and the resolutions passed at the meetings of the men ask for cabs as good as those on the North Eastern and on the American roads.

The unjust treatment to which many railroads are subjected in the columns of the daily press is aptly illustrated by the case of the Illinois Central. Some of the Chicago dailies cannot refer to the road without employing offensive epithets and no opportunity is lost to influence public opinion against it; and yet this same road pays the state 7 per cent. of its gross earnings on the 705 miles of original road, amounting at present to nearly \$700,000 per year. It has altogether paid about fifteen and one-half millions into the state treasury, and twice in the last fiscal year it has come to the aid of the state by paying \$300,000 of its taxes in advance. It has spent four or five millions in improvements within the limits of Chicago in the last three or four years, and is now altering the grade of its tracks near the terminals, building sea walls, and co-operating with the city in the improvement of the Lake Front park at an outlay to itself of a million or two, but of course these things should not count in its favor or influence the action of the dailies referred to.

In a series of tests conducted on the Buffalo & Niagara Falls Electric Railway by Messrs. H. O. Pond and H. P. Curtis and published in the *Sibley Journal of Engineering*, the following results were obtained:

Friction of the car on straight level tracks	208.5 pounds
Traction coefficient on straight level tracks	6.86 pounds per 1000
Acceleration horse power, from zero to full speed	16.03 horse power
Average current taken by the car in passing over the entire line	63.4 amp
Average voltage on the line, from several tests	513.1 volts
Average electric horse power of car over the entire line	40.44 horse power
Average drop in potential on Buffalo end of line	5.1 per cent
Average speed over the entire line	23 miles per hour
Maximum speed, on a regular run	36 miles per hour
Maximum current taken by car during tests	138 amp
Maximum voltage at car during tests	588 volts
Maximum electric horse power of car during tests	143 horse power

During these tests the cars never carried a full load, but generally ran light. The track and overhead construction are of the best. The road has only two grades in its entire length of 22 miles. The cars are 28 feet long over the body, 36 feet over all and weigh 22,000 pounds, with the motors and without passengers. They are carried on the Brill Company's pivotal trucks, each truck having two G. E. 800 motors,

With a view of increasing railway construction in India, the Government has announced that on proposed branch and feeder lines approved by it, it will give a guarantee of interest of 3 per cent. per annum on the authorized capital, while in some cases it may be arranged as an alternative that a payment be made to the branch company sufficient to bring up the earnings of the latter to 3½ per cent. on the authorized capital, provided always that the main line company is not called upon to pay more than it has earned from the new traffic. In order to take advantage of these concessions, the branch lines in question must not exceed 100 miles in length. A prior right to construct such feeders will be given to the administrations of the trunk lines, but if they do not undertake it the matter may be taken in hand by other parties. The plans and estimates must be approved by the Government, and any further capital expenditure after completion must also be sanctioned by the same authorities. The Government agrees to provide the land required free of cost, inclusive of quarries, ballast pits, brick fields, etc., and to provide and maintain the telegraph service at the usual charges for such work. Materials for construction will be carried over the State lines at special rates. The

Government reserves the right to purchase such lines at the end of 21 years, at a cost of not more than 30 per cent. above the capital cost of the line nor less than the par value of the same.

According to an article by Mr. Charles E. Barry, in the *Sibley Journal of Engineering*, there is but one producer gas engine plant in commercial operation in this country, and that was built in 1892 by the Danbury & Bethel Car and Electric Company, of Danbury, Conn., for the purpose of supplying electric light to the towns of Danbury and Bethel. The station equipment consists of three 100-horse-power horizontal engines, built by the Otto Gas Engine Works, of Philadelphia, belted to a jack shaft carrying a three-ton flywheel, and from which one 750 and one 1,500-light Westinghouse 1,000-volt alternator, two commercial and three street arc machines are driven. The gas engines are of the twin-cylinder type, having two horizontal cylinders placed one above the other, and working on the one crank. The cylinders are 14½ inches in diameter and 25 inches stroke. In a test these engines produced a horse-power-hour for each 1.129 pounds of coal used in the producer, equivalent to .979 pounds of combustible per hour. The gas per one horse power per hour was 76.3 cubic feet. The engines ran at 164 revolutions per minute. Of the total heat supplied to the engine 39.09 per cent. was absorbed by the jacket water, 25.61 per cent. passed out in the exhaust, 13.66 per cent. was lost through radiation, etc., and 21.64 per cent. converted into useful work. The mechanical efficiency of the engines was 85.39 per cent., and the dynamos 81.53 per cent. The efficiency of the producers was 84 per cent. The jack shaft consumed 35 horse power.

Personals.

W. W. Finley has been chosen Vice-President and Manager of the Great Northern.

Mr. H. H. Rogers, of New York, has been chosen President of the Ohio River Railroad.

Mr. J. E. Cannon has been promoted to the position of Master Mechanic of the Great Northern at Barnesville, Minn.

Mr. Frank T. Hyndman has been appointed Master Mechanic of the Pittsburgh & Western, vice J. N. Kobaugh, resigned.

Mr. Frank Singer has been appointed Master Mechanic of the Midland Terminal Railway, with headquarters at Gillett, Col.

Mr. W. V. McCracken has retired from the Presidency of the Louisville, St. Louis & Texas owing to the reorganization of that property.

Mr. S. W. Fordyce has been made Receiver of the Stuttgart & Arkansas River Railroad, and Mr. H. E. Martin is Manager for the Receiver.

Mr. J. M. Schoonmaker, of Pittsburgh, Pa., has been chosen Vice-President of the Pittsburgh & Lake Erie, to succeed Mr. James H. Reed, resigned.

Mr. R. F. Hoke, President of the Georgia, Carolina & Northern, has been chosen President of the North Carolina Car Company in place of Mr. Julius Lewis.

Mr. H. N. Woodward has been appointed Master Mechanic of the Baltimore & Ohio shops at Parkersburg, to succeed Mr. J. H. Irvin, assigned to other duties.

Mr. D. L. Anderson has been appointed Secretary and Purchasing Agent of the Louisville, Evansville & St. Louis, with headquarters at Evansville, Ind.

W. S. Calhoun, who has been the railroad representative of the Brussels Tapestry Company, of Chauncey, N. Y., has been appointed General Manager of the Company.

Mr. Attila Cox, receiver of the Louisville St. Louis & Texas, has been chosen President of the reorganized company, which will be known as the Louisville, Henderson & St. Louis.

Mr. George S. Edgell has been elected Second Vice-President of the Long Island Railroad. He is a son-in-law of the late Austin Corbin, formerly President of the Long Island Railroad.

Mr. Wm. P. Palmer has been elected Second Vice-President of the Illinois Steel Company, vice Mr. Robert Forsyth, resigned. He will look after the commercial interests of the company.

Mr. C. H. Warren has resigned as General Manager of the Montana Central, which has heretofore been operated by the Great Northern, and it will hereafter have its own corps of officials.

Mr. William J. Fransioli has been appointed Acting General Manager of the Manhattan Railway, of New York City, to succeed F. K. Hain, deceased. He was formerly chief clerk to General Manager Hain.

Mr. W. R. Stirling has resigned the Vice-Presidency of the Illinois Steel Company to devote his entire time to the Universal Construction Company, which recently leased the north works of the Illinois Steel Company.

Mr. O. O. Winter, Division Superintendent of the Great Northern at Minneapolis, Minn., has resigned to accept the position of General Manager of the Brainerd & Northern Minnesota, with headquarters at Brainerd, Minn.

Mr. W. E. Looney has retired from the position of Master Car Builder of the Louisville, Evansville & St. Louis, and the office has been abolished. The master mechanic will hereafter have charge of the car department.

It is announced that Mr. Archie McLean has been appointed Superintendent of Motive Power and Equipment of the Georgia Northern road, vice Mr. Albert Marugg, resigned. Mr. McLean's headquarters will be at Piddock, Ga.

Mr. Parley I. Perrin, for many years Superintendent of the Taunton Locomotive Works, died at Taunton last month, in the eighty-fourth year of his age. He joined the Taunton Locomotive Works as draftsman and foreman in 1846.

Mr. C. B. McCall, General Freight and Passenger Agent of the Chicago, Paducah & Memphis, has been appointed General Manager of the Kitchfield, Carrollton & Western, with headquarters at Carlinville, Ill., in place of Mr. T. D. Hinchcliffe, resigned.

Mr. C. P. Clark has been appointed Assistant General Manager of the New England Railroad, with office at No. 180 Summer street, Boston. The duties of the Assistant General Manager will be the same as those assigned by the Board to the General Manager.

Mr. J. J. Turner, Vice-President and General Manager of the Vandalia Line, will remove his headquarters from Terre Haute, Ind., to St. Louis, Mo., July 1. Mr. Charles R. Peddle, Purchasing Agent of the road, will also remove his headquarters to St. Louis at the same time.

Mr. St. John Boyle has been made sole Receiver of the Chesapeake, Ohio & Southwestern, owing to the death of Gen. John Echols, who was associate Receiver and General Manager. Mr. Boyle will also act as General Manager until the road is turned over to the Illinois Central.

Mr. E. L. Weisgerber has been appointed Master Mechanic of the Mt. Clare shops of the Baltimore & Ohio Railroad. He was formerly Master Mechanic of the shops at Newark, O. Mr. William Harrison, Jr. has been appointed Master Mechanic of the shops at Newark, O., to succeed Mr. Weisgerber.

Mr. E. S. Marshall, formerly Master Mechanic of the St. Louis & Southwestern Railroad, is now Assistant Manager of the Railway Equipment Company, of St. Louis, which manufactures and sells the Houston track-sanding device, the economical slack adjuster and several other railroad devices. Mr. Marshall is also Manager of the Railroad Department of the Missouri Malleable Iron Company, of East St. Louis, Ill.

Mr. D. B. Robinson has accepted the Presidency of the St. Louis & San Francisco, which is undergoing reorganization, and has tendered his resignation as First Vice-President of the Atchafalaya, Topeka & Santa Fe, to take effect July 1. Mr. Robinson has been in railway service since 1866, and has been First Vice-President of the A., T. & S. F. since March 7, 1893. His headquarters as President of the St. Louis & San Francisco will be at St. Louis, Mo.

Arthur B. Underhill, for many years Superintendent of Motive Power of the Boston & Albany, died at Springfield, Mass., May 24. He was born at Chester, N. H., October 23, 1832, and entered railway service in 1860 as Foreman Repair Shops, Boston & Worcester. From 1864 to 1880 was Master Mechanic of the Boston & Worcester. He was appointed Superintendent of Motive Power of Boston & Albany, September 1, 1880, which position he held until December, 1893, when he resigned on account of ill health.

On June 18th the degree of Doctor of Engineering was conferred by the faculty and trustees of Stevens Institute upon Commodore George W. Melville, Engineer-in-Chief of the United States Navy, in appreciation of the excellent engineering work performed by Commodore Melville for his country and the advancement of the science of steam engineering, so well illustrated in the world-wide famed "white squadron." Only once before in the 25 years' history of the Stevens Institute has the degree of Doctor of Engineering been conferred, and then upon Prof. R. H. Thurston, of Rhode Island, who formerly occupied the chair of Mechanical Engineering in Stevens Institute and is now Director of Sibley College, Cornell University.

Mr. Edwin M. Winter, General Manager of the Chicago, St. Paul, Minneapolis & Omaha, has been selected by the Northern Pacific Reorganization Committee to be President of the company. Mr. Winter has been with the Chicago, St. Paul, Minneapolis & Omaha since 1876. He was born in Vermont in 1845, and entered railroad service in 1867. His first work was in the construction department of the Union Pacific, where he remained for about three years. Subsequently he was a contractor's agent for construction work on various railroads, General Claim Agent for the Chicago & Northwestern, General Superintendent of the West Wisconsin, and has held his present position of General Manager since 1885.

Mr. Austin Corbin, President of the Long Island Railroad, was fatally injured by a runaway team at his summer residence at Newport, N. H., on June 4. Mr. Corbin was born at Newport, N. H., July 11, 1827, and graduated from the Harvard Law School in 1849. In 1851 he removed to Davenport, Ia., where he lived for 14 years. He located in New York in 1865 and established the banking house of Austin Corbin & Company. Soon thereafter he secured control of the Long Island Railroad, which he extended from year to year, until it has become a great system, reaching almost every portion of Long Island. He was at different times interested in many other railway enterprises, being President of the Indiana, Bloomington & Western; President of the Philadelphia & Reading road from September, 1866, to June 27, 1890; President of the Elmira, Cortland & Northern, and in 1892 was for a few months President of the New York & New England.

Gen. John B. Gray, Vice-President of the American Brake Company, whose home for several years has been in Brooklyn, N. Y., died of Bright's disease at Asheville, N. C., on June 6, 1896, after a lingering illness. General Gray was born at Sheridan, June 25, 1831. The beginning of his business career was in New York City, but, on becoming of age, he removed to St. Louis Mo., where he was engaged in mercantile business for some ten years prior to the war. He had an honorable career during the war, and at its close was offered at different times several important positions in the service of the government. These he declined. In 1880 he became connected with the American Brake Company, of St. Louis, of which he was President for several

years. In 1888 he was instrumental in effecting a lease of the American Brake Company to the Westinghouse Air Brake Company, and has, since that time, had general charge of the eastern business of the driver brake department of the Westinghouse Air Brake Company. During the past two years his health has been continually declining. Last summer he went abroad for several months, and shortly after his return he went to Asheville, N. C., where, the climate seeming to benefit him, he commenced building a home, which was not yet quite completed at the time of his death.

Equipment Notes.

The Erie Railroad is in the market for 20 locomotives.

The Chicago, Paducah & Memphis road is negotiating for 500 to 1,000 cars.

The Cleveland, Lorain & Wheeling has placed an order with the Peninsular Car Works for 300 30-ton flat cars.

The Barney & Smith Car Company is building three closed and fourteen open cars for the Mount Clements electric road.

The Georgia & Alabama Railroad has ordered eight passenger coaches from the Ohio Falls Car Manufacturing Company.

About 100 refrigerator cars are being fitted up at the Philadelphia, Wilmington & Baltimore shops at Wilmington, for the shipment of fruit.

The Michigan-Peninsular Car Company, Detroit, Mich., has received an order from the Lehigh Valley Railroad Company for 50 double-deck stock cars.

The Ensign Manufacturing Co., of Huntington, W. Va., has been awarded the contract for 100 thirty-ton hopper gondola cars for the Chesapeake & Ohio.

The Ohio Falls Car Manufacturing Company has received an order from the Baltimore & Ohio Southwestern Railroad Company to repair 600 freight cars.

The Chicago, Burlington & Quincy has placed orders for 1,000 stock cars; 750 to go to the Michigan Peninsular Car Company and 250 to the Wells & French Company.

The Florida & East Coast Railroad has placed an order with the Elliott Car Works for 100 freight cars. This road is in the market for additional equipment.

At the shops of the Pennsylvania, at Fort Wayne, there have recently been completed 175 gondola cars, and work has been now commenced on the building of 25 cars for dairy product and 10 large furniture cars.

The Wagner Palace Car Company's shops have turned out two compartment cars for service on the Chicago & Northwestern road, which are considered superior in beauty of finish to anything ever turned out of the shops.

The Billmeyer & Small Car Company, York, Pa., has under construction four cars for Bolivia, South America, where they will be used for excursion purposes. They are also building four for Venezuela, adapted for carrying sugar cane.

The Brooklyn Heights electric road, Brooklyn, N. Y., has recently added to its equipment a third theater car, built by the J. G. Brill Company, Philadelphia, Pa. The length over end panels is 24 feet; width at sill, 7 feet and width at Belt rail, 7 feet.

The Texas Midland Railroad has placed an order with the St. Charles Car Company for \$125,000 worth of rolling stock. The order includes seven new coaches, five baggage cars, fifty furniture cars, ten tank cars, five cabooses and a private car.

The Imperial Railways of North China will receive proposals for building four passenger and four freight locomotives for use on the extension of the road from Tien Tsin to Lu-Kon-Chiao.

The bids will be opened at the company's office at Tien Tsin, August 25.

It is announced that the Northern Pacific is about to change four of its standard mogul 18 by 24 engines into compounds. They will all be different types—Richmond, Schenectady, Brooks and Pittsburgh. The intention is to put them into service, running against simple engines.

Four new sleeping-cars have just been sent from the Wagner Palace Car shops, at East Buffalo, to St. Paul, Minn., for use on the Chicago, St. Paul, Minneapolis & Omaha. These are the first Wagner cars used on the road, this company having recently taken the business away from the Pullman Company.

The Illinois Central has awarded a contract for 500 coal cars to the Wells-French Company, and 300 refrigerator cars to the United States Rolling Company. These last named cars will be built at the Hegewich plant of the company. It is rumored that the road will soon place another and large order for cars.

The contracts for some of the 75 Baltimore & Ohio engines were let shortly after our June issue went to press. Other contracts followed and the orders are now distributed as follows: Richmond Locomotive Works, 25; Baldwin Locomotive Works, 20; Pittsburgh Locomotive Works, 20, and Cook Locomotive Works, 10.

At a recent test of the Baldwin-Westinghouse Electric Locomotive at the shops of the Westinghouse Air Brake Company, at Wilmerding, Pa., a speed of 45 miles an hour was developed, the engine hauling 25 freight cars. In the near future a public test of the engine will be made, to which a large number of railroad men will be invited.

Eight new coaches and six new Wagner Sleeping cars have been put into the daily through service between New York and Montreal, via the Adirondack & St. Lawrence division of the New York Central. The day coaches have accommodations for first and second-class passengers. New mail and express cars will also be assigned to these trains.

As illustrating the heavy expense which railroads are compelled to incur in equipping the cars with automatic brakes and couplers, it may be cited that the receivers of the Baltimore & Ohio have asked and obtained authority from the court to borrow \$409,851 in addition to money already spent for the equipment of the rolling stock with brakes and couplers in conformity to law.

It has been stated in several papers that the Richmond Locomotive Works has received an order from the Chicago, Cleveland, Cincinnati & St. Louis Railway to convert 60 locomotives into compounds. This is not true. They are to convert a few engines only at present, and if they are satisfactory others may be changed from time to time, as they require heavy repairs on the cylinders and attached parts.

The Doherty Patent Combined Vise and Winch.

Brown, Jaeger & Company, No. 919 Betz Building, Philadelphia, Pa., are the sole manufacturers of the Doherty combined vise and winch, which is shown in the accompanying cut. The manner of using it is apparent at a glance. This tool will evidently in a short time replace the old-time "strap and vise" or "block and fall" used at present in telegraph, telephone, trolley wiring, electric light line work, in tightening guy wires, in putting up suspension wires for aerial cables, pulling up wires and in cutting out slack. In fact it



can be used for stringing wires of every description upon poles or fixtures of any kind and in tightening all gages of wire to any advisable degree of tension.

It is available for use in making repairs to "live wires" without the necessity of employing the usual "cut outs" thus preserving

the linemen from the danger of the "cut out" falling off. The tool itself being entirely of metallic construction completes the circuit. On electrical test it has been shown, that the Doherty combined vise and winch shows no resistance. The usefulness and worth of the implement is summed up in the following statement: One man can pull up two miles of wire at one time with greater ease, more quickly and more effectively, than the usual gang of four men can pull up two ordinary sections with the "strap and vise" or "block and fall" in use at present. As an indication of its power, it is only necessary to state that it can pull apart a No. 8 iron wire in an ordinary section. Its merit lies in saving money, labor, time, and life. The weight of the tool is about six pounds.

The Niagara Spray Ejector for Urinals.

To economize in the use of water and also to overcome the annoyance from clogging, so often experienced in flushing slab urinals by means of perforated pipe, S. J. Putnam, Prince's Bay, N. Y., has brought out the fixture shown in the appended illustrations.

The ejector shown in Fig. 1 may be secured into the front side of



Fig. 1.

the supply pipe which passes across the stall, in the place of perforated pipe.

The force of water on the internal spherical head of the screw cap at the slot, throws a fan-shaped spray obliquely against the slab, flushing the entire surface in an efficient manner. As the outlet is

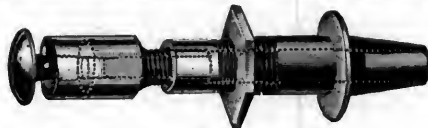


Fig. 2.

equal to only two holes in a perforated pipe, a large saving of water is evident, and owing to its peculiar construction there is but little chance for clogging. If the spray should become clogged by rust or dirt it can be instantly cleared without disturbing the couplings. A minimum of pressure may be obtained by using a stop-cock, which will also add to the amount of water saved. The screw-cap has a lock, therefore no part can get lost or destroyed.

The special coupling shown in Fig. 2, is used for high slab work



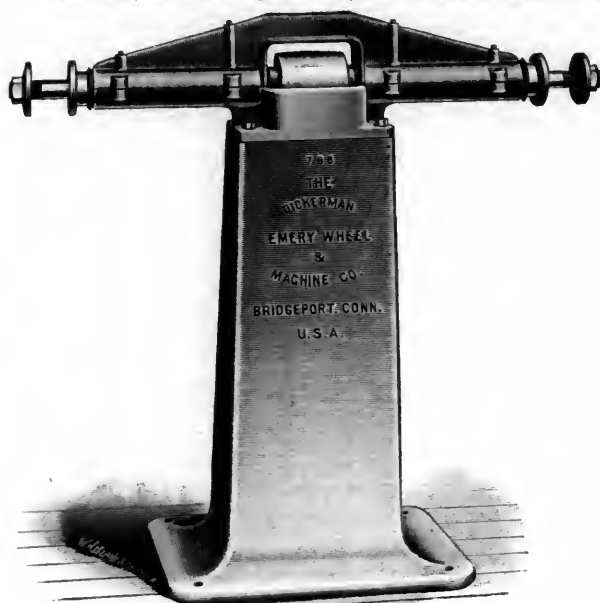
Fig. 3.

where the supply pipes are behind the slab. It passes directly through the slab and is clamped firmly to the same by the nut, which is provided with left-hand thread.

Fig. 3 shows two stalls with fixtures complete and water turned on. Mr. Putnam will cheerfully furnish fuller information to those of our readers writing him

The Dickerman Buffing Lathe.

The buffing lathe illustrated herewith is made by the Dickerman Emery Wheel and Machine Company, Bridgeport, Conn., and is a departure, to a certain extent, from machines of this character. The spindle has a bearing the entire length of each box, precluding any whipping or jumping of the spindle from belt action. It is



Dickerman Buffing Lathe.

turned from machinery steel and means are provided for taking up end thrust. A maximum amount of room beneath the spindle for buffing large pieces is obtained by having no projections on either the base or the underside of the boxes. The machine is especially adapted for buffing bicycle frames and similar work. The dimensions are: Height, floor to center of spindle, 40 inches; diameter of spindle in bearings, $1\frac{1}{4}$ inches; diameter of spindle at wheel fit, $1\frac{1}{2}$ inches; length of bearings, $14\frac{1}{2}$ inches each; length of spindle, 50 inches; distance between fields, 40 inches; spindle pulley, 6-inch face by 5-inch diameter; floor space over all, 22 by 50 inches. The Pratt & Whitney Company, 123 Liberty street, New York City, are the New York agents.

A New Locomotive Boiler Covering.

The accompanying cut shows a new fireproof covering recently brought out by the Kelley Company, of Mineral Point, Wis., to meet the want of master mechanics for a lagging for boilers that is



fireproof, that can be removed for repairs and again replaced, and that is cheap.

This covering is composed of strips of wood, treated in such a way as to be incombustible, and fastened together side by side so that every fourth strip is raised about one-half inch above the surface of the other three, these raised strips either being notched, as shown in the cut, or left whole. As this side is placed next to the boiler, it will, of course, form air spaces, which may, or may not, be filled with mineral wool, as desired. These strips have a backing of heavy

paper board covered with asbestos paper, the whole being securely fastened together without nails or other metal fastening. It may thus be sawed or cut out to fit rivets or seams, and can also be made of any size to fit the sheets, and any curvature of the boiler. This covering is very strong, and may be walked on without injury. By means of the new patented device for fastening it on, any section of the covering may be removed at any time for repairs or examination and again replaced, without disturbing or loosening any other section. It gives a smoother surface for jacketing than wood lagging, and when it is further known that the cost is only about the same as that of wood, it will readily be seen that it is worthy of careful consideration.

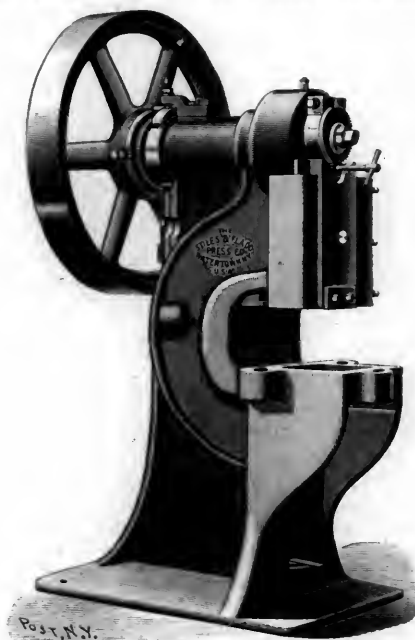
Improved Punching Press.

In the accompanying cut we illustrate a new punching press, which, while it follows in a general way the well-known Stiles press, embodies certain improvements. No great innovation can be introduced into a design of a punching press, in which a frame is in one solid casting, but the company putting this improved Stiles press on the market make their especial claim for excellence of workmanship and the selection of each separate kind of material of which the press is constructed.

Only a special mixture of iron of great strength is used in their castings and this mixture is continually tested and every care taken to keep it up to an established standard. Every part on which the slightest wear occurs is carefully scraped to an exact fit and a perfect bearing surface thereby provided.

The ways or guides of the slide are made exceptionally long to resist any side thrust without undue wear. The clutch adopted by this company to be used on this press in preference to all others, is one that has been perfected and recently patented by the inventor of the original Stiles clutch and Stiles press and is claimed to be superior in many ways to that well-known clutch. Among the special features we note the ability to run the press in either direction equally well; three points of contact in the wheel cause the clutch to be practically instantaneous; the operator can cause the press to make a whole revolution or only a part, as he may desire which is a valuable feature, as it prevents accidents to tools and operators, and makes this clutch absolutely safe. The clutch can be used to back out a punch that may become stuck in the die, and is claimed by the manufacturers to be the latest and best press clutch built.

These presses are manufactured by the Stiles & Fladd Press Company, of Watertown, N. Y., in six sizes weighing from 500 to



Stiles & Fladd Punching Press.

7,500 pounds, as fly presses, and in five sizes ranging in weight from 1,200 pounds to 8,000 pounds, as geared presses. The patterns are so constructed that an endless variety of modifications and changes can be made to adapt them to special work and tools of any make.

The Q & C Hoyt Flush Car Door.

The accompanying drawings show the new Q & C Hoyt Flush Car Door, which is being brought out by The Q & C Company. It will be noticed that there are several new features embodied in this door that are worthy of careful investigation, the first of which is an absolutely flush door, hanging from the top without a bottom rail of any kind. This entirely does away with any danger of injury to the door at this point, besides reducing the weight and number of fixtures nearly one-half.

The parts needed at the top of the door are two hangers, the track and the track brackets, and the only parts used at the bottom of the door are a sliding guide bracket and catch which recedes into the sill of the car as the door closes. This is a novel feature in itself, which has been demonstrated to be thoroughly practical as nothing projects from the side of the car to be knocked off.

The locking device at the rear edge of the door is of such a design as to make it positively necessary to break the seal before the car can be entered. Besides this it acts as a leverage to throw the door into place and hold it there. The power of this lever is so great that it will throw a badly sprung door into its place with but little effort, making an absolutely storm-proof door.

As a flush door it is claimed to be the cheapest in first cost, to have the least number of parts, to be easy to apply, and that the expense of maintenance is but very little, if anything.

The Star Pipe Wrench.

The accompanying cut illustrates the star pipe wrench, which is manufactured by the Van Auken Steam Specialty Company, C. P. Monash, Manager, 208 South Canal street, Chicago. This wrench is simple in construction, having but three pieces, which are made with such care and uniformity as to be perfectly interchangeable. It is claimed for this wrench that it does not stick on the pipe, but releases instantly, that it has no lost motion, that it cannot mash the pipe or slip off, and it is guaranteed never to strip, having an oval top thread. On account of the "slant" on the heel, it will also ratchet a nut or coupling without marring or rounding the corners.



A contract has been awarded by the Receivers of the Baltimore & Ohio Railroad Company to the Continuous Rail Joint Company, of Newark, N. J., for 50,000 rail joints.

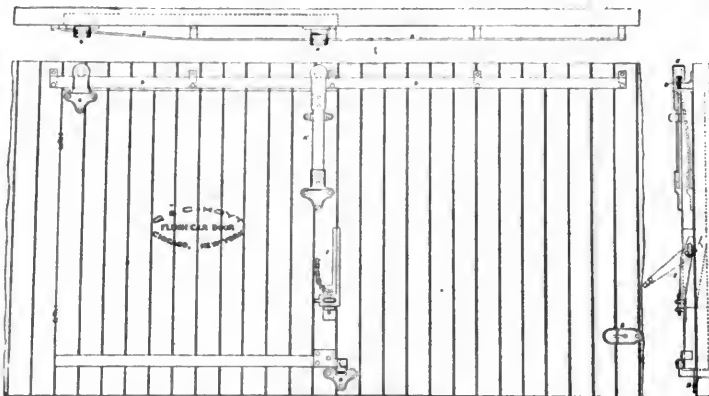
Messrs. Bruner, Sprague & Co., 1027-8 Manhattan Building, Chicago, agents for the Sall Mountain, Georgia, asbestos, besides very flattering sales of their product to railroad for boiler covering, report a call for the asbestos from Japan.

The Gibbs Electric Company, 160 to 177 Clinton street, Milwaukee, Wis., have issued a number of illustrated sheets showing the different styles of motors which they build. Among these is a type M motor direct belted to a quartering machine, also a 20-horse power steel clad motor geared to a Hiles & Jones Company bar shear.

The Georgia Car and Manufacturing Company, of Savannah, will erect a plant to consist of an engine and boiler house, 75 by 109 feet; a machine, blacksmith and workshop, 106 by 375 feet; a building for the office; also warerooms, patterns and cabinet work, 106 by 150 feet; a shop for passenger cars, 106 by 500 feet, etc.

The Standard Car Wheel Company, of Cleveland, O., has been incorporated, with a capital stock of \$75,000. The incorporators are: N. P. Bowler, of Bowler & Company; C. A. Brayton, formerly of Maher & Brayton; W. L. Bowler, W. B. Brayton and Francis J. Wing. The new company has purchased the car wheel foundry of Bowler & Company.

If any of our readers do not thoroughly understand the new and simple method by which lead pipe can be coupled to lead pipe or to iron pipe instead of wiping or soldering the joints, they should write at once to The Van Auken Steam Specialty Company, 208



The Q & C Hoyt Flush Car Door.

South Canal street, Chicago, for their illustrated catalogue of Star Lead-pipe Couplers and Fittings. In doing so please mention this journal.

The Clayton Air Compressor Works, Havemeyer Building, New York, report a gratifying increase in their volume of business during the past few months, over the same period last year. The rapid extension in the field of application for compressed air was foreseen by these works several years ago, when they discontinued other lines and devoted their sole time and attention to the manufacture of air compressing machinery. A description of their latest pattern of Duplex Compressor, installed at the Pennsylvania shops at Altoona, will shortly appear in these columns.

The Brown Hoisting & Conveying Machine Company have closed

a contract with the Pennsylvania Railroad for one Brown double cantilever machine for handling general merchandise on Pier J, Jersey City, to and from ocean steamers to cars. This machine has been designed especially for its location. It will hoist its maximum load of five tons 150 feet per minute, while the entire machine will be able to travel along the pier at the rate of 600 feet per minute. It is operated by steam and will be handled by a single operator. It is said to be the first machine specially designed for the rapid handling of freight to be erected in New York harbor.

The Chicago Rawhide Manufacturing Company, 75 East Ohio street, Chicago, Ill., have for the past eighteen years been manufacturing rawhide pinions. Their extended experience enables them to turn out a superior article—one that has met with the greatest success. The pinions are noiseless and greatly reduce the friction; furthermore, they do not wear out the meshing gear, yet they outwear metal pinions, thereby effecting a great saving in both directions. The company also make rawhide bell and register cord, remarkable for its strength and durability. Other products of their factory are leather belting, and rope for rope transmission. In connection with the latter they have a patented connection for making a splice without increasing the size of the rope, while retaining its full strength, thus overcoming a great objection to ordinary rope transmission, either by manilla or wire rope.

New Publications.

COMPRESSED AIR.—A monthly publication devoted to the useful application of compressed air. Published by W. L. Saunders, 26 Cortlandt street, New York. Subscription price, \$1.00 per year.

This interesting periodical is only four months old, but it has developed wonderfully in that brief period. The rapidly extending use of compressed air for power purposes in all kinds of shops, in contractors' work, and in other lines too numerous to mention, gives this paper a large and growing field. From its pages it is evident that its editors and publisher are directing the attention of its readers to the thoroughly practical uses of compressed air and the most economical methods of employing that useful agent. That is just what is needed, and we can heartily commend the publication to those who are or ought to be interested in the compression, transmission or use of air.

HEALTH AND PLEASURE ON "AMERICA'S GREATEST RAILROAD." *Descriptive of Summer Resorts and Excursion Routes, Embracing more than One Thousand Tours by the New York Central & Hudson River Railroad.* Issued by the Passenger Department. New York; 532 pages; 6 by 9 inches. (Standard size.)

Each year the guide books which are published by the different lines of railroad are increased in size and elaborateness. The discoveries which have been made in the various processes of photo-engraving have facilitated very much the production of this class of literature, and have made possible a richness of illustration which our fathers never dreamed would be possible.

The volume before us has been issued by the passenger department of the New York Central Railroad, and is intended to set forth the attractions of that great line of travel.

At the beginning of the book is an excellent large folded map 3 ft. 3½ inches by 16 inches of the line and its connections from Boston to St. Louis. The different single-track roads are represented by one broad red line, double track by two and quadruple track by four.

The first chapter is devoted to a general description of the New York Central Railroad and its branches. The second chapter—33 pp.—to the Hudson River division and its environment, with a great many illustrations of interesting places and objects along and adjacent to the road. Among them are a number of historical scenes and much beautiful landscape.

The third chapter describes the Putnam division of the road, and the counties and places adjacent thereto. Excellent views are given of the High and Washington bridges in New York, buildings and scenes along the line of the road; some of them, such as the scene opposite p. 72, are of great beauty. Following this chapter is one of 34 pp. devoted to the Harlem division, and containing many admirable illustrations. "The Beautiful Mohawk Valley" is the title of the succeeding chapter, and embraces that part of the line from Albany to Utica. Other chapters describe the Lake Region of Central New York, the Auburn road, Rochester to Buffalo and Niagara Falls, Rochester and Niagara Falls road, the Adirondack Mountains, with a multiplicity of views of lakes, mountains and hotels. About 70 pp. are devoted to descriptions of places which may be reached by the New York Central road. The terminal facilities in New York are described, and about 90 pp. are given up to information concerning steamboat and stage lines, followed by schedules which relate directly or indirectly to the great road which is the subject of this elaborate volume.

About 50 pages are devoted to tables, giving rates of fare, lists of hotels and boarding-houses along the line, and much other information of interest to travellers. Over 100 pages of very interesting advertisements complete the book.

It is not easy in a brief notice like this to give an adequate idea of the wealth of illustrations which are given. The mere enumeration of them would take a great deal of time. It is safe to say that there are several hundred. Most of them are of a very excellent character of engraving. A number of them—as for instance that on page 140, "Great Expectations,"—have much artistic merit.

The style of the descriptive matter is very pleasant, and there is a grateful absence of the guide-book style, which in some productions of this kind is so "averting." The price of the book is 25 cents, and is the cheapest publication we know of for the money. The fault to be found with it is that its perusal produces a desire—which is difficult to resist—to pack up and take an early train to some of the agreeable places which are described.

Our Directory

OF OFFICIAL CHANGES IN JUNE.

We note the following changes of officers since our last issue. Information relative to such changes is solicited.

Alchison, Topeka & Santa Fe.—Mr. D. B. Robinson has resigned the office of First Vice-President.

Baltimore & Ohio.—Mr. E. L. Weisgerber, formerly Master Mechanic at Newark, O., has been transferred to the position of Master Mechanic of the Mont Clare shops, Baltimore. Mr. Wm. Harrison, Jr., succeeds him at Newark. Mr. H. N. Woodward has been appointed Master Mechanic at Parkersburg to succeed Mr. J. H. Irvin, assigned to other duties.

Brainerd & Northern Minnesota.—Mr. O. O. Winter has been appointed General Manager, with headquarters at Brainerd, Minn.

Chesapeake, Ohio & Southwestern.—Gen. J. Echols, Receiver and General Manager, died May 24. Mr. St. John Boyle has been made sole Receiver, and will act as General Manager until the road is turned over to the Illinois Central.

Georgia Northern.—Mr. Archie McLean has been appointed Superintendent of Motive Power, with headquarters at Pidecock, Ga., vice Mr. A. Marugg, resigned.

Great Northern.—Mr. W. W. Finley has been elected Vice-President and General Manager. Mr. J. E. Cannon has been appointed Master Mechanic at Barnesville, Minn.

Houston, East & West Texas.—T. W. House has been chosen President.

Litchfield, Carrollton & Western.—Mr. C. B. McCall has been made General Manager, with headquarters at Carlinville, Ill., vice Mr. T. D. Hinchcliffe, resigned.

Long Island.—Mr. George S. Edgell has been elected second Vice-President. Mr. Austin Corbin, President, was killed in an accident last month.

Louisville, Evansville & St. Louis.—Mr. D. L. Anderson has been appointed Secretary and Purchasing Agent, with headquarters at Evansville, Ind. Mr. W. E. Looney has resigned the position of Master Car Builder, and the office is abolished.

Louisville, St. Louis & Texas.—Mr. W. V. McCracken has retired from the Presidency, and is succeeded by Mr. Attila Cox. The reorganized road will be known as the Louisville, Henderson & St. Louis Railroad.

Manhattan.—Mr. Wm. J. Fransioli has been appointed Acting-General Manager, vice Col. F. K. Hain, deceased.

Midland Terminal.—Mr. F. Singer has been appointed Master Mechanic, with headquarters at Gillett, Col.

Montana Central.—Mr. C. H. Warren has resigned the position of General Manager. The road will not be operated hereafter by the Great Northern, but will have its own corps of officials.

New England.—C. P. Clark has been appointed Assistant General Manager, and will perform the duties heretofore performed by the General Manager. Office, 180 Summer street, Boston.

New Orleans & Western.—J. M. Turner, Superintendent of Motive Power, has been appointed General Manager. C. B. Deason has been appointed Chief Engineer.

Northern Pacific.—Mr. Ed. M. Winter has been elected President.

Ohio River.—Mr. H. H. Rogers has been chosen President.

Pittsburgh & Lake Erie.—Mr. J. M. Schoonmaker has been chosen Vice-President, to succeed Mr. J. H. Reed, resigned.

Pittsburgh & Western Railway.—Frank T. Hyndman has been appointed Master Mechanic, vice I. N. Kolbaugh, resigned.

Sherman, Shreveport & Southern.—Mr. F. W. Pratt has resigned the position of General Manager and the duties of the office will devolve upon the Superintendent.

St. Louis & San Francisco.—Mr. D. B. Robinson has been elected President, with headquarters at St. Louis.

Stuttgart and Arkansas River R. R.—S. W. Fordyce is Receiver. H. E. Martin is Manager for Receiver.

Wisconsin & Quebec.—Mr. R. T. Rundlett has resigned the position of President and General Manager. Mr. H. Ingalls has been elected President, and Mr. W. F. P. Fogg, General Manager.

Exhibits at the Conventions.

The exhibits at the conventions were larger and more numerous than on any previous year and were worthy of careful and minute inspection and study. The following is a complete list of them:

Adams & Westlake Company, Chicago; curtain fixtures, etc. Represented by L. A. Gray, T. B. Jones and H. E. Keeler.

Alexander Car Replacer Manufacturing Company, Scranton, Pa.; steel engine and car replacers. Represented by E. B. Whitcomb.

American Balance Slide Valve Company, San Francisco, Cal., and Jersey Shore, Pa.; slide valves. Represented by J. T. Wilson.

American Brake Beam Company, Chicago; Kewanee brakebeam. Represented by E. G. Buchanan and J. G. Sanborn.

American Steel Foundry Company, St. Louis; car trucks, bolsters, cast steel locomotive frames, couplers and steel castings in general. Represented by C. B. Evans, J. W. Robinson, E. F. Goltra.

American Steel Castings Company, Thurlow, Pa.; cast-steel driving wheel centers, locomotive frames and other steel castings. Represented by D. Egan, S. A. Watson and W. A. Blanchard.

Armstrong Bros., Chicago; machinists' tools and supplies. Represented by P. Armstrong.

Ashton Valve Company, Boston; safety valves and steam gages. Represented by F. A. Casey.

Automatic Dumping Car Company, New York; door-operating device for hopper-bottom cars. Represented by Wm. McMahon.

Boston Belting Company, Boston; rubber goods. Represented by Geo. H. Forsyth, J. F. Muldoon, Fred T. Alden, T. R. Freeman.

Burrows Company, E. T., Portland, Me.; car curtains. Represented by Harry H. Russell.

Brown Automatic Car Coupler Company, Columbus, Ind.; car couplers. Represented by W. G. Irwin and P. C. Brown.

Barbey & Company, F. A., Boston; Hampson flexible steam joint. Represented by F. A. Barbey.

Buckeye Malleable Iron & Coupler Company, Columbus, O.; Little Giant Coupler. Represented by J. E. Howe, J. Timms, C. D. Bailey, C. H. McKibbin and R. C. Fraser.

Bundy Manufacturing Company, Binghamton, N. Y.; time recorder. Represented by H. E. Bundy and C. J. Morehouse.

Bushnell Mfg. Company, Easton, Pa.; car seats. Represented by E. Bushnell and C. Pullman.

Bourne, E., Vancouver, B. C.; Fader dump car.

Baker, William C., New York; car heater. Represented by W. C. Baker and J. G. Demarest.

Bird & Son, F. W., East Walpole, Mass.; car roofing. Represented by M. A. Garrett.

Boston Woven Hose and Rubber Company, Boston; rubber goods. Represented by A. L. Whipple, Jr.

Bridgeport Car Equipment Company, Bridgeport, Conn.; third rail system for electric cars.

Brussels Tapestry Company, Chauncey, N. Y.; car window and berth curtains, mattresses, rugs, bed linings and the "Perfect" self-adjusting curtain fixture. Represented by W. S. Calhoun.

Brill Company, J. G., Philadelphia; model of truck. Represented by L. B. Snyder.

Bruner, Sprague & Company, Chicago; asbestos lagging for locomotives, fire-proofing and insulation for cars. Represented by H. C. Bruner and J. H. Sprague.

Chase & Company, L. C., Boston; plush goods. Represented by R. Bishop, Jr.

Chicago Grain Door Company, Chicago; grain door and security lock bracket. Represented by J. L. Mallory.

Chicago Pneumatic Tool Company, Chicago; pneumatic hammers, sand-papiering machines, piston air drills, air hoists, flue expanders, pneumatic belt shifters, and other pneumatic devices. Represented by J. W. Duntley, W. O. Duntley, J. F. DeGarmo, I. W. Davis and J. Hoyer.

Chicago Railway Equipment Company, Chicago; National Hollow brake-beam. Represented by E. B. Leigh, A. J. Farley, L. C. Burgess and F. Ely.

Consolidated Car-Heating Company, Albany, N. Y.; Pope light. Represented by C. A. Sheldon, J. F. McElroy, W. N. Stevens, R. P. Scales, W. P. Cosper and F. P. Foley.

Carnegie Steel Company, Pittsburgh; steel cars. Represented by T. C. Carson, George H. Wightman, H. M. McIlwain, H. J. Lindsay and J. B. Hardie.

Crown Car Coupler Company, Troy, N. Y.; car coupler. Represented by F. Walter and G. H. Mowers.

Crosby Steam Gage and Valve Company; gages and valves. Represented by E. C. Bates.

Detrick & Harvey Machinery Company, Baltimore, Md.; bolt-cutting machinery. Represented by T. M. Brown.

Davis Car Soade Company, Portland, Me.; car shades. Represented by E. E. Piper and C. M. Fuller.

Eureka Nut Lock Company, Pittsburgh; nut locks for car construction. Represented by S. D. Barnett.

Evans Artificial Leather Company, Boston, Mass.; leather substitute for upholstering car seats. Represented by W. N. Dole and A. E. Prince.

Falls Hollow Stay Bolt Company, Cuyahoga Falls, O.; stay bolts and stay-bolt iron. Represented by C. M. Walsh and J. W. Walsh.

Foster Engineering Company, Newark, N. J.; governors, reducing valves, automatic safety stop valves, in-line injector checks and reducing valves. Represented by J. M. Foster.

French Renovating Process Company, Cleveland, O.; process for cleaning car plushes. Represented by H. Stern.

French Spring Company, Pittsburgh; box lids and springs. Represented by L. C. Noble and Geo. Morris.

General Agency Company, New York; Smith triple expansion exhaust pipe. Represented by C. A. Ball, J. Y. Smith and J. R. Ellicott.

General Electric Company, Schenectady, N. Y.; photographs of motors. Represented by W. J. Clark, L. H. Parker, C. C. Pierce, F. H. Shepard and W. B. Potter.

Gold Car Heating Company, New York; system of car heating. Represented by E. E. Gold and E. H. Gold.

Goodwin Car Company, Chicago; model, drawing and photographs of the Goodwin dump car. Represented by J. M. Goodwin, G. T. Plowman and N. Senbert.

Gould Car Coupler Company, New York; freight and passenger couplers and spring buffer blocks for freight cars. Represented by C. M. Gould, Dr. C. W. Gould, A. Dowdell, W. F. Richards, F. P. Huntley and Geo. E. Widner.

Gifford Car Coupler Company, Chicago; car coupler. Represented by M. R. Clapp.

Gisholt Machine Company, Madison, Wis.; tool-grinder. Represented by F. V. Bartlett, W. H. Kruse and F. H. Robinson.

Grady, M. J., Kingston, Ont., car coupler. Represented by M. J. Grady.

Greeley & Company, E. S., New York; Acme packing waste. Represented by E. B. Eaton.

Hammett, M. C., Troy, N. Y.; Corey Force Feed Oiler, pneumatic bell ringer, guide, and rod oil cups, Richardson balance valves. Represented by M. C. Hammett.

Hicks, John B., New York; Bellamy filler, R. I. Clark & Company's varnishes and japans, and New Jersey Car Spring and Rubber Company's hose, etc. Represented by J. B. Hicks and C. L. Bellamy.

Hale & Kilburn Manufacturing Company, Philadelphia; car seats. Represented by H. S. Hale, C. E. Barrett and H. T. Bigelow.

Hancock Inspirator Company, Boston; inspirators. Represented by C. E. Randall and T. Aldcorn.

Harris, E. W., Fallsade, Nev.; variable exhaust nozzle.

Hodge & Company, Samuel, Detroit; McCoy sight feed lubricators. Represented by E. McCoy.

Haeseler Company, The C. H., Philadelphia; portable pneumatic tools.

Ingersoll-Sergeant Drill Company, New York; triplex, two-stage steam air compressor and 8 by 8 belt-actuated compressor. Represented by C. W. Shields.

Interchangeable Brake Beam Company, St. Louis; brake beam. Represented by J. C. Stewart and E. H. Power.

Jerome Metallic Packing Company; Jerome packing and McIntosh "duplex" blow-off cock. Represented by G. C. Jerome.

Johns Manufacturing Company, H. W., New York; asbestos fire-felt boiler and pipe covering, car roofing, paints, vulcanized packing. Represented by F. M. Patrick.

Jenkins Brothers, New York; Jenkins 1896 valve, Sellers injectors. Represented by J. D. Stiles and C. W. Martin, Jr.

Kanally Company, M. E., Cambridgeport, Mass.; Standard car-door hanger. Represented by M. E. Kanally.

Kinzer & Jones Manufacturing Company, Pittsburgh; composition brake shoes. Represented by J. J. Kinzer and Wm. Veleberack.

Keasbey & Mattson Company, Ambler, Pa.; magnesia boiler covering. Represented by W. W. Johnson and G. Rose.

Knitted Mattress Company, Canton Junction, Mass.; knitted mattresses. Represented by G. F. Summer.

Leach, H. L., Boston; track sander.

Lewis Tool Company, New York; vices. Represented by E. T. Leavenworth.

Look, J. C., San Jose, Cal.; unlocking lever for couplers.

Major A., New York; filter and cement.

Manning, Maxwell & Moore, Ashcroft Manufacturing Company, Consolidated Safety Valve Company, Hayden & Derby Manufacturing Company; Ashcroft steam gages, Muffler pop valves, encaused locomotive valves, Tabor indicator, Metropolitan injector, and Manning, Maxwell & Moore tools. Represented by C. A. Moore, J. N. Derby, J. N. Gardner, A. C. Stebbins, R. A. Bole, D. W. Pedrick and F. T. Tapley.

Massachusetts Mohair Plush Company.

McKibbin & Company, C. H., New York. Represented by C. H. McKibbin, Chas. D. Bailey, R. C. Fraser.

Moran Flexible Steam Joint Company, Louisville, Ky.; steam joint. Represented by H. U. Frankel and T. W. Moran.

More, Jones & Company, St. Louis; car and engine brasses. Represented by F. A. Johann.

Morris Box Lid Company, Pittsburgh; box lids. Represented by Geo. Morris.

Motley & Company, Thornton, N. Y.; the LeBel electric kindler. Represented by W. W. Caldwell.

New York Belting and Packing Company; rubber goods. Represented by A. F. Conklin.

Norton, A. O., Boston; jacks.

New York Rubber Company, New York; rubber goods. Represented by Frank Scofield.

National Malleable Castings Company, Cleveland; Tower coupler, National car-door fasteners, Enbank doors and malleable castings for cars. Represented by Willard A. Smith, C. L. Sullivan, S. L. Smith, J. V. Davison, F. H. Angell and F. B. Whitlock.

National Car Wheel Co., Buffalo; car wheels. Represented by W. W. Turley.

National Machinery Company, Tiffin, O.; blue prints of machines. Represented by F. Bloom.

National Car Coupler Co., Chicago; the national coupler. Represented by J. Hinson.

New York Coupler Company, New York; car coupler. Represented by P. H. Wilhelm.

One Piece Drawbar Company, Chicago; Deitz tender passenger and freight couplers and Ogden train jack. Represented by H. Deitz.

Pugh, Job T., Philadelphia; drills, augers, etc.

Peerless Rubber Manufacturing Company, New York; rubber goods. Represented by C. H. Dale, C. S. Prosser and W. J. Courtney.

Pedrick & Ayer, Philadelphia; automatic belt air compressors, air lifts, pneumatic grinding and drilling machines, pneumatic riveter, pneumatic chipping and calking tools. Represented by D. W. Pedrick, C. H. Haeseler and Howard A. Pedrick.

Plush Renovating Company, Baltimore; process for cleaning plushes. Represented by Chas. H. Winkelmann and H. E. Wilkes.

Q. & C. Company, Chicago; McKee brake adjuster, Williams locomotive valve-setting device and Q. & C. flush door. Represented by C. F. Quincy, F. Ely, E. W. Hodgkins, F. E. Came and J. K. Lencke.

Railroad Supply Company, The, Chicago; the Hein double automatic coupler and car jack. Represented by Phil Hein, C. A. Herriman.

Reliance Replacer Company, Jersey Shore, Pa.; wrecking frogs.

Revere Rubber Company, Boston; rubber specialties. Represented by W. B. Miller, George Q. Hill, W. B. Miller, Wm. Killmer, T. A. Budd, E. Z. Jefferson, John W. Teller, George A. Gardner and Richard Kutzleb.

Ross Valve Company, Troy, N. Y., valve. Represented by Wm. Ross.

Ruth Equipment Company, Pittsburgh; sleeping-car berths with pneumatic cushions, etc. Represented by L. F. Ruth, J. B. Ruth and George Miller.

Star Brass Manufacturing Company, Boston; track sanders, pop safety valves, steam gages, whistles, air-brake and inspector's gages. Represented by C. W. Sherburne and E. C. Sawyer.

Safety Car Heating and Lighting Company, 160 Broadway, N. Y.; the Plintsch light. Represented by A. W. Soper, Robert Andrews, R. M. Dixon, M. P. Stevens, E. P. Slocum and O. C. Gayley.

Sewall, J. H., Worcester, Mass.; "Standard" brake slack adjuster.

Shackle, Harrison & Howard Iron Company, St. Louis; cast-steel body and truck bolsters. Represented by T. M. Gallagher.

Sams Automatic Car Coupler Company, Denver, Col.; model couplers on model cars. Represented by C. G. Burkhardt and L. D. Sweet.

Smith & Company, Edward, New York; preservation of metal surfaces. Represented by A. Johnson and E. H. B. Twining.

Standard Steel Works, Philadelphia; locomotive tires, steel tired locomotive and car wheels. Represented by M. Middleton, C. Riddell and T. L. Courtney, Jr.

Springfield Malleable Iron Company, Springfield, O.; Miner and Bryan draft rigging and the Ludlow freight, passenger and tender couplers. Represented by R. Ludlow, J. T. Ricks and A. Ludlow.

Schirra Seal Company, Pittsburgh; car seals. Represented by Schirra and G. Fivel.

Schoen Pressed Steel Company, Pittsburgh, Pa.; pressed steel bolsters. Represented by C. T. Schoen and J. T. Milner.

Smillie Coupler Company, Newark, N. J.; car coupler. Represented by C. H. Taylor.

Smart Car Door Company, Nashua, N. H.; flush car door. Represented by H. D. Smart.

Taylor Iron & Steel Company, High Bridge, N. J.; Taylor steel tired wheels. Represented by W. J. Taylor.

Taylor Company, N. & G., Philadelphia, tinplate and Pancoast ventilator. Represented by M. J. Cusick.

Tilden Company, B. E. Chicago; wrecking frog. Represented by B. E. Tilden.

Trojan Car Coupler Company, Troy, N. Y.; car coupler. Represented by A. H. Renshaw, H. N. Loomis, W. C. DeArmond and E. Dietz.

Universal Construction Company, Chicago; Harvey and Pennock steel cars. Represented by W. H. Stirling.

Universal Safety Car Bearing Works, Jersey City, N. J.; Baker's universal safety car bearings. Represented by J. R. Baker.

Vose & Cliff Manufacturing Company, New York; King's yielding side bearings. Represented by E. Cliff.

Whitman & Company, Clarence, New York; Pantasote, a substitute for leather. Represented by H. E. Twining and H. M. Grier.

Western Railway Equipment Company, St. Louis; Houston locomotive track sander, combination lug and follower, economy slack adjuster and American journal box. Represented by E. S. Marshall.

Wilson & McIlwain, Pittsburg; Clancy's hose clamp, Wadsworth, Howland & Company's paints, Wells lights, Keystone soft metal unions, Sewall's brake slack adjuster, and Hutchins' roof. Represented by J. T. Wilson and J. D. McIlwain.

Wolstencroft's Sons & Company, Wm., Philadelphia; pneumatic hammers. Represented by G. B. Harris and Wm. H. Curtis.

Yerdon, Wm., New York; double hose band. Represented by Wm. Yerdon.

Zenner-Raymond Disinfectant Company, Detroit, Mich.; disinfectant. Represented by A. H. Zenner.

Souvenirs at the Conventions.

As usual, there were a number of souvenirs distributed at the conventions. We only have room to publish a list of them, without attempting descriptions, though many of them are worthy of praise:

American Brake Company, St. Louis; views of the destruction wrought by the St. Louis tornado.

Boston Belting Company, Boston; glass paper weights, pen wipers and whist counters.

Brown Holating and Conveying Machine Company; pass books.

Brown & Sharpe, Providence, R. I.; three-inch scales.

Buckeye Malleable Iron and Coupler Company, Columbus, O.; pocket knives.

Ewald Iron Company, St. Louis; paper cutters.

Flood & Conklin Company, Newark, N. J.; pocketbooks.

Forster Engineering Company, Newark, N. J.; trick match safes.

Jenkins Brothers, Jersey City, N. J.; whist counters.

Morris Box Lid Company, Pittsburgh, Pa.; corkscrews.

National Machinery Company, Tiffin, O.; match safes.

Peerless Rubber Manufacturing Company, New York; pocket knives.

Pocket List of Railroad Officials, 336 Pearl street, New York; 12-inch folding steel rules.

Pratt & Lambert, 47 John street, New York; note books with aluminum covers.

Revere Rubber Company, Boston; glass paper weights.

Safety Car Heating and Lighting Company, 160 Broadway, New York; card cases.

Smillie Coupler & Manufacturing Company, Newark, N. J.; note books.

Standard Paint Company, 81 John street, New York; note books.

T. Prosser & Son, 115 Gold street, New York; playing cards.

W. W. Laurence & Co., Pittsburgh, Pa.; lead pencils in the form of a hollow nail containing adjustable leads.

AMERICAN RAILWAY MASTER MECHANICS ASSOCIATION.

Abstracts and Summaries of Reports Presented at the Twenty-Ninth Annual Convention.

Exhaust Pipes and Steam Passages.

ROBT. QUAYLE, WM. FORSYTH, J. McNAUGHTON, W. S. MORRIS, D. L. BARNES, PROF. W. F. M. GOSS, Committee.

The work was outlined by the committee, as follows:

First. Determine the angle of the exhaust steam jet.

Second. The effect of the shape of the orifice on the angle and shape of the jet.

Third. Determine the effect of height of bridge on the direction of the individual jet.

Fourth. Vary height of nozzle with best form of orifice and height of bridge, as determined by tests two and three, from the highest to the lowest practicable point, with the form of stack recommended by last year's committee.

Indicator cards to be taken to also determine the effect of change of form of orifice on the back pressure in the cylinder.

Fifth. Vary the length of the stack recommended by last year's committee, with nozzle located at the most efficient point as determined by the fourth test.

Sixth. Vary the heights of straight stack that last year's committee recommended, nozzle located the same as in fifth test.

Seventh. Vary the size of the nozzle with the best arrangement of parts, as already determined.

Eighth. Comparative results of double and single nozzles.

It was agreed that work under the first three points should be undertaken in connection with the locomotive testing plant of Purdue University, at Lafayette, Ind., and that the remainder of the work should be done in connection with the testing plant of the Chicago & Northwestern Railway, at West Chicago shops. This division gave to the Purdue University the study of the form and density of the exhaust jet (Part I), and to the Northwestern the study of its efficiency, as effected by all the various changes suggested by the outline (Part II).

PART I.

FORM AND CHARACTER OF THE EXHAUST-STEAM JET.

The methods employed in this study and the apparatus used were practically the same as described by Professor Goss before the Western Railway Club, in October, 1895, in his paper, "A Glimpse of the Exhaust Jet." The conclusions from these investigations are given by the committee as follows.

1. The action of the exhaust jet within the stack is not that of a piston within the barrel of a pump.

2. Draft can as well be produced by a steady flow of steam as by the intermittent exhaust jet.

3. The exhaust jet, under ordinary conditions, does not fill the stack until near its top.

4. The vacuum within the stack at points near its base is greater than that within the smokebox.

5. The jet acts upon the smokebox gases in two ways; first, by frictional contact it induces motion in them, and second, it enfolds and entrains them.

6. In all jets examined the induced action was relatively strong and the entraining action weak.

7. Any condition which will tend to solidify or to reduce the spread of the jet appears to affect favorably its efficiency.

8. Changes in stack proportions may greatly affect the form of the jet.

9. In general, a change in the amount of steam discharged will change the form of the jet, the spread being reduced as the volume of steam is increased.

10. Other things being the same, the form of the jet is not much affected by changes in speed or of cut-off.

11. The form of the nozzle has much to do with the form of the jet, and hence with its efficiency.

The experiments of the committee disprove the pump-action theory of the exhaust. They show that the jet of steam does not fill the stack at or near the bottom; that under certain conditions common to practice it touches the stack only when it is very near the top; and finally, that a jet of steam flowing steadily from the exhaust tip, the engine being at rest, results in draft conditions which are in every way similar with those obtained with the engine running, the same amount of steam being discharged per unit of time in each case. These facts will doubtless be accepted as proof of the statement that the smokebox gases are not forced out by the action of the steam jet.

Enough has not yet been done to define the precise action of the jet, but it may be said with certainty (1) that it acts to induce motion in the particles of gas which immediately surround it, and also (2) that it acts to enfold and entrain the gases which are thus made to mingle with the substance of the jet itself.

It is clear that any design of nozzle which will serve to subdivide the stream, or to spread it so as to increase its cross-section, will assist the jet in its effort to entrain the gases, but it is not clear that there is any gain to be realized in such a result. It is possible that, as the mixing action is increased, the induced action may be diminished, and that the sum total of the effect produced may remain nearly constant. The work which has thus far been done is not conclusive on this point, but the evidence tends to show that the more compact and dense the jet, the higher its efficiency.

Interesting diagrams of the form of the exhaust jet at different speeds, with various nozzles, and several different inside diameters of stacks are presented by the committee. A comparison of the form and location of similar lines in different jets shows the effects produced by the different combinations of pipes, nozzles, etc.,

which were experimented upon. While making such a comparison, it is of interest to remember that a vacuum gage attached to the side of the stack at a point 13 inches above its base always gave about one and one-half (1.5) times the vacuum recorded by the smokebox vacuum gage; and that a second gage attached within 10 inches of the top of the stack gave a vacuum approximately equal to six-tenths (0.6) of the vacuum in the smokebox. The diagrams show that increased speed results in less spreading of the jet, and a better vacuum, but the latter is due to the greater volume of steam passing, and not to the rapidity of the exhaust impulses. By blocking the slide valves clear of their seats and opening the throttle slightly the committee were enabled to cause a steady blow through the exhaust in which the weight of steam passed was practically the same as in some of the trials of the regular jet. The results, as already stated, show that there is no essential difference in the effects of the two kinds of jets.

The portion of the exhaust pipe above the top of the bridge serves to combine and to straighten the jet. The lower the bridge the greater the length of this combining or straightening pipe, and a more dense and compact jet is delivered from the nozzle. A nozzle ending in a plain cylindrical portion two inches in length gave better results than either a nozzle contracted in the form of a frustum of a cone, or a nozzle in the form of a plain cylinder ending in an abrupt cylindrical contraction, the jet from the first-named nozzle being more solid and efficient.

A false "chock," reducing the diameter of the stack from 16 inches to 12 inches, widens the angle of the lower part of the jet, the outer walls of which it especially affects. The chock acts as a throttle on the delivery of the combined stream of gases, and by so doing produces a material reduction in the velocity of currents of gas and steam within the smokebox for points about the jet and immediately below the stack; this reduced velocity allows the steam jet to "upset," or broaden.

PART II.

These tests were made on the Chicago & Northwestern testing plant at the West Chicago shops, with engine 797, a ten-wheel Schenectady locomotive, with 19x24 inch cylinders, 56-inch driving wheel centers, having an eight-foot firebox, 40½ inches wide, located on top of the frames. The engine was fitted with five draft gages, two at the smokebox and three at the firebox; a Boyer speed-recorder; two Bristol recording gages, one showing the boiler pressure, and the other connected to the exhaust cavity in the left cylinder saddle. Indicator cards were taken from both cylinders, those from the left side being taken with a 100-pound spring, while on the right side a 10-pound spring was used and the piston provided with a stop at 20 pounds in order to show the back pressure accurately. Constant conditions in the firebox could not be obtained with coal and the grate was therefore blocked with firebrick except an opening of about 180 square inches, and petroleum used for fuel.

The actual work performed was not exactly that outlined by the committee, as more work than was anticipated was found to be necessary to determine the best features of the design of an exhaust pipe, and, in consequence, some of the work on stacks as outlined in parts five and six was not reached.

The work on this testing plant relates principally to the proper design of an exhaust-pipe and nozzles for maximum efficiency, and the results obtained are believed to confirm the following conclusions, all of which are established only within the limits of the experiments, and for the arrangement of smokebox, boiler and flues used in the tests:

First. The exhaust-pipe should be as short as possible with a proper arrangement of diaphragm and netting, provided this does not make it less than 10 inches high, which was the lowest limit tested.

Second. The bridge in this pipe should not be less than 13 inches high.

Third. The area of each of the openings of the pipe at the most contracted part should be not less than the area of the nozzle. (This conclusion may only be true for the particular form of pipe and location of the choke used in the above experiments.)

Fourth. When it is necessary to reduce the area of the exhaust opening, it should be done at the nozzle and not at the choke.

Fifth. The nozzle should be raised when necessary by lengthening the portion of the pipe above the top of the bridge, rather than below.

Sixth. The exhaust tip ending in a plain cylindrical portion 2 inches in length in these tests gives better results than either a nozzle contracted in the form of a frustum of a cone or a nozzle in the form of a cylinder with an abrupt cylindrical contraction at the orifice.

Seventh. The distance from the choke of the stack to the nozzle for 14-inch choke stack 52 inches long should not exceed 50 inches, nor be less than 40 inches for maximum efficiency.

Eighth. The distance from the top of the smoke arch to the nozzle with 14-inch straight stack 52 inches long, should not be greater than 38 inches nor less than 23 inches.

Ninth. The distance from the top of the smoke arch to the exhaust nozzle, with a 16-inch straight stack 52 inches long, should not be greater than 38 inches nor less than 23 inches.

Tenth. The efficiency of the steam jet is reduced by spreading it by means of cross bars in the nozzle.

Eleventh. Cross-bars not wider than ¾-inch placed in the nozzle or above it nearer than 1 inch increase the back pressure; wider cross-bars increase the back pressure when further removed in proportion to their width.

Twelfth. A petticoat pipe with the single nozzle, when properly arranged, increases the efficiency of the jet.

Thirteenth. Double nozzles, with 14-inch choke stack and 16-inch straight stack 52 inches long, are not as efficient as single nozzles, the difference being very slight.

Fourteenth. Double nozzles should be located with reference to the stack the same as single nozzles.

Conclusions from the Von Borries-Troske tests (see AMERICAN ENGINEER, CAR BUILDER AND RAILROAD JOURNAL for March and May, 1896) on the effect of various lengths of conical and cylindrical stacks:

Fifteenth. The maximum height of stack, measured from the exhaust nozzle of the diameter at the choke is properly chosen, need not exceed five times this diameter. For cylindrical stacks the ratio of diameter to height is the same.

Sixteenth. The vacuum increases as the stack is shortened and more rapidly with cylindrical than with conical stacks.

Seventeenth. The decrease in vacuum due to shortening the stack within certain limits can be nearly overcome by lowering the nozzle. The amount which the nozzle should be lowered with cylindrical stacks is almost equal to the amount the stack is shortened.

With conical stacks the nozzle should be lowered about two-thirds as much as the stack is shortened.

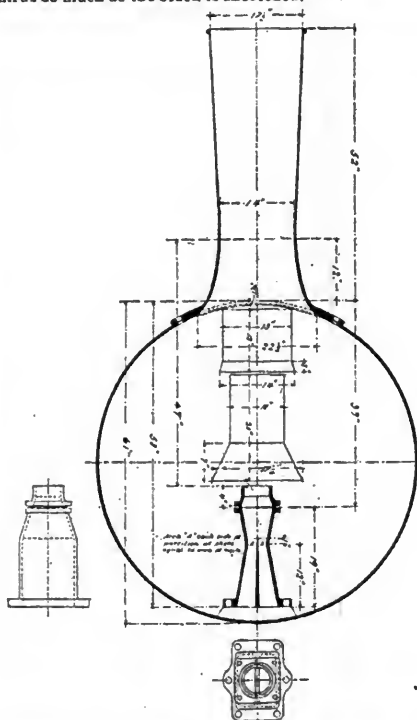


PLATE 48.

Plate 48 shows the arrangement of exhaust pipe, nozzle, petticoat pipe and stack, which gave the best general results as to vacuum and efficiency in the committee's tests. An inspection of the results of the tests in Part II. will show that certain variations from the above change but slightly the effectiveness of the draft appliance. The limits within which the different parts experimented with can be changed without materially affecting the efficiency of the apparatus as a whole are as follows:

First. Height of the bridge should not be lower than that shown, although lowering it decreases the efficiency but little.

Second. Distance of the nozzle from the choke of the stack can be from 49 inches to 39 inches, preferably nearer the former than the latter.

Third. The area of each opening at the choke of pipe can be decreased below the area of the nozzle as much as 20 per cent., without greatly decreasing the efficiency at speeds and cut-offs experimented with. Preference to the larger opening should be given with engine working generally at short cut-offs.

Fourth. The petticoat pipe can be made to considerably increase the efficiency of the draft apparatus in boilers of this diameter and probably larger, but it must be carefully adjusted to the exact draft conditions of the engine. This can probably only be done with the engine in actual service. In boilers of smaller diameter, a petticoat pipe is probably of little or no service. The committee's tests are not sufficiently comprehensive to give the limits of this adjustment. They indicate, however, that the top of a 13-inch top section should not be higher than 2 inches below the top of the smokebox with 14-inch choke or 16-inch straight stack.

Fifth. The 14-inch choke stack could probably be shortened without materially affecting the vacuum. By how much, the committee's tests do not show. A straight stack must be larger than 14 inches diameter, but neither 14-inch nor 16-inch straight stacks give as good results as the choke stack, although the 16-inch straight stack shows much better results than that 14 inches in diameter.

Slide Valves.

G. R. HENDERSON, W. H. THOMAS, E. E. DAVIS, PHILIP WALLIS,
L. R. POMEROY, Committee.

Your committee on "Slide Valves" was given two problems to solve: 1st, To consider different types of balanced valves, and to determine their economy and efficiency over plain unbalanced valves; and 2d, To determine the economy and efficiency of Allen ported valves over plain valves.

BALANCED VALVES.

This report will deal only with such styles of balanced valves as are now in actual service on railroads. From the replies to the circular of inquiry (constituting only 52 out of the total membership of over 600) we find that of 10,934 locomotives on 50 roads, 7,241 are equipped with balanced valves of some type, and that 145 have piston valves, the latter mostly on compounds. The balanced valves are distributed about as follows:

Richardson	5,915	Delaney	42
Morse	482	Margach	30
Barnes	283	Leeds	8
American	297		

In regard to the amount of balance used on the valves, there was a great variety in the statements, which ran from 49 per cent. to 95 per cent. of the total valve area, though the greatest number, by far, gave between 53 per cent. and 65 per cent. of the total valve area.

The valves tested by your committee had balance areas as follows.

	Square inches.	Per cent.
Richardson valve	97.95	56
Sim bal. American	99.40	59 1/2
Double bal. American	106.30	66

It should be borne in mind, however, that the taper of the American rings, with steam pressure on the outer circumference, will tend to force the valve down on the seat, overcoming in part the much larger balancing area.

The answers to the question relative to the wear of seats and valves per unit of distance indicated that a wear of from $\frac{1}{16}$ inch to $\frac{1}{8}$ inch per 100,000 miles might be expected with balanced valves, with from two to three times as much for unbalanced valves, while the wear on the link motion varied in about the same proportion.

The expressions in regard to piston valves were all favorable with one exception, this being with a road with five compound locomotives with piston valves.

The different styles of balanced slide valves may be brought down, generally, to two types, viz: Those whose balanced area is enclosed by straight strips, and those who balanced area is enclosed by circles.

It was decided that the Richardson and the American valves could well be taken to represent the two types. One single-balance and one double-balance American valve were tested at Purdue University, and one Richardson valve—the strips were afterward removed from this, the hole in crown plugged, and it was then used as a plain unbalanced valve.

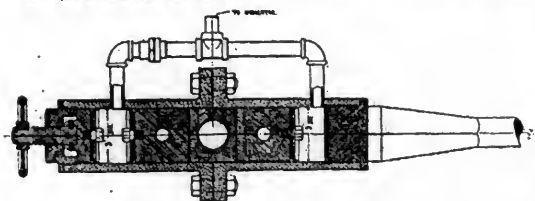


Plate 1—Section Through Dynamometer.

To get comparative results, the valve seat on the cylinder was filed and scraped to a true surface before the commencement of the test, and the different valves were put in the engine and worn down to a bearing. All tests were made on the right side of the locomotive, and in the forward motion only. The valves used were all new.

In order to measure and record the force necessary to move the valves a dynamometer (see Plate 1) was connected by a hinged pipe with an ordinary indicator the motion of the drum being taken from the valve stem. While this dynamometer was rather a crude affair and not one that the Committee would recommend for accurate work, on account of the variable friction of the leathers and the method of taking up the water used by the indicator, yet it was the best that the Committee could obtain, and every effort was made to secure results that could at least be comparable. The dynamometer and the indicator gave one inch height on the diagrams for 800 pounds on the valve stem. Steam chest and cylinder diagrams were taken simultaneously and a large and regular flow of oil from the lubricator was maintained. In the friction tests about 150 miles were run and over 600 cards taken in this and the Allen port experiments.

It was decided to work in the first, eighth, eleventh, thirteenth and fourteenth notches, and at speeds of 10, 20 and 40 miles per hour, and as these notches gave cut-offs of 21%, 18%, 14%, 9% and 6% inches respectively, it was believed that the range was sufficient.

In order to explain the different curves of the friction diagrams obtained the unbalanced diagram at first notch and 20 miles per hour, is reproduced on Plate 2, as a representative type of the set. The difference in height between the forward and backward

strokes is due to the steam pressure on the area of the valve stem, which resists forward motion, and assists backward. This is shown by the shaded area (see Fig. 1).

The lines *a-b* and *c-d* (Fig. 2, Plate 2) show the load resulting from the inertia of the parts. As far as the friction of the valve is concerned, there must also be a correction for inertia. In order to show the valve friction, free from the effects of inertia and the area of valve stem, Fig. 3, Plate 2 has been constructed, correction having been made for both of these points. This enables one to analyze the valve friction at various points of the travel, by placing under the diagrams a section of valve and seat, and moving the valve to the various positions. This curve (Fig. 3) is for the backward stroke only, and the analysis appears in Fig. 4, reference being made to several letters.

A corresponds to the extreme front end of travel, and at B the full pressure is registered on the indicator at the end of the pipe, and the curve falls from the friction of rest to the friction of motion. From C to D the valve becomes partly balanced by the portion overhanging steam port N, and reduces the friction. From D to E port N closes, the steam expands, reducing the balance, and the friction rises slightly. From E to F the steam in port N expands more, slightly increasing the friction. From F to G compression begins in port M, increasing the balance and diminishing the friction slightly. From G to H the steam in port M is exhausted, diminishing the balance and increasing the friction. From H to I the admission of steam in port M increases the balance and the friction drops, and from I to J the valve moves from off port M and the friction increases. From J to K, the end of travel, the conditions remain nearly constant.

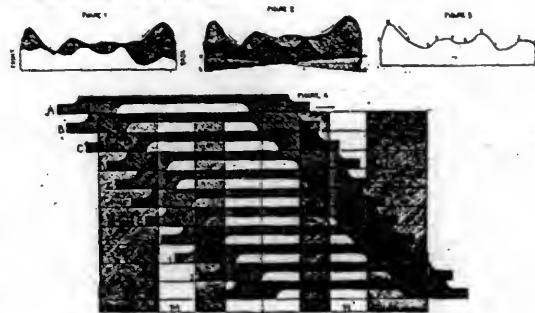


Plate 2—Diagrams from Dynamometer.

It would require too much time and space to thus analyze all the diagrams, but those who wish to study the effects closely can proceed as indicated above.

The committee found it was unable to determine the stuffing-box friction, but this would probably be constant. It is found that the unbalanced valve requires twice as much work to move it as the balanced valves, and your committee believes that this will represent the average results in ordinary railroad practice. Of course, by balancing a large area, the friction could be still further reduced, but the danger of the valves lifting off its seat would be rather great. Your committee, therefore, recommends the following rule for balancing slide valves:

Area of balance = area of exhaust port + area of two bridges + area of one steam port.

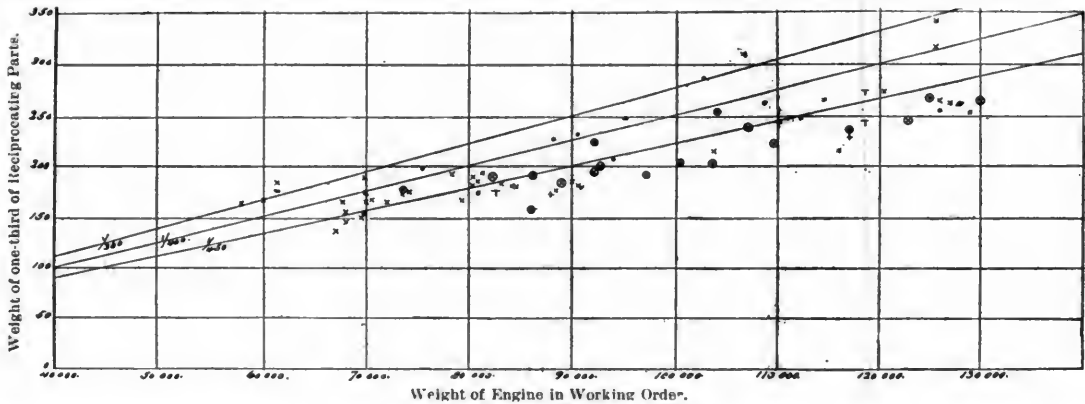
The above is to obtain for both Allen and plain valves.

Your committee had hoped to be able to give the results of some experiments with a piston valve on a simple locomotive but were not able to do so.

ALLEN VALVES.

The responses to the circular developed the fact that of 10,934 engines on 50 roads, 513 were equipped with the Allen ported valve. Incidentally, it may be mentioned that all but one were balanced. The great majority are used in passenger service only, though several advised that they made no distinction in the use of this type of valve. It also appeared that in some cases an engine with an Allen valve was given one or two more cars than an engine with a plain valve, and also that less lead was used. While the majority of replies showed that the Allen valve was satisfactory and especially advantageous at light speeds and early cut-offs, yet a few condemned the valve as having no advantage over the plain type. Some have substituted long ports in place of the Allen valve, one case of which your committee knows, having used ports 23 inches long on a 19 x 24-inch cylinder. This was to obviate the breaking and imperfect coring of the Allen valve.

In order to obtain strictly comparable indicator cards, a false seat was prepared to take an Allen valve with the same elements and motion as the plain valve. The runs were made in the 1st, 8th, 11th, 13th, 14th and 15th notches, and at speeds of 10, 20, 30, 40, 50 and 60 miles per hour, as far as it was possible to obtain them. As might have been expected, the indicator cards show that the mean effective pressure with the Allen port is greater than without it at the ordinary running positions. The average shows 20 per cent. in favor of this valve. Of course it must not be concluded that this 20 per cent. will be gained without an increase in fuel, for from the nature of the argument it has been shown that more steam is admitted to the cylinders, and hence more fuel is necessary, but it can be considered that the Allen port has enabled the piston to exert 20 per cent. more useful pressure on the crosshead for each stroke. It is



Locomotive Counter-Balancing.—Fig. 1.

also readily apparent that the earlier the cut-off the more is gained by the Allen valve. This is also true in a measure of the increase of speed, although it is not so marked as in the case of the ratios of expansion. It is also clearly demonstrated that a better steam line can be obtained. Long ports, or increased travel, may give us good results by the indicator, but here again come the increased weight and area of valve, or the greater speed and longer stroke, both of which mean increased power absorbed in moving the valve with corresponding wear on seat and link motion. This Allen valve weighed 125 pounds, against 85½ pounds for the plain valve, and the total area was only 190 square inches, against 161½ square inches for the plain valve, and in the case of an engine already built, both of the other methods seem impractical, whereas the Allen valve is easily applied.

Your committee, therefore, believes that this 20 per cent. increase in piston power, due to the Allen valve, can often be realized in practice, and that it must certainly mean greater power developed by the engine, though not necessarily greater power per unit of fuel consumed.

CONCLUSION.

In concluding this paper your committee desire to thank the Purdue University and Professor Goss in particular for the use of the laboratory and services of their assistants, without which it would have been difficult to proceed with the work. Mr. Wilson, of the American Balance Slide Valve Company, also deserves the thanks of the committee for furnishing two valves and steam-chest covers and valuable assistance at the tests, and the same remarks apply to Mr. Hammett, who furnished two Richardson valves and the false seat, as well as doing much hard work with the committee at Purdue. They also wish to express the indebtedness due the Schenectady Locomotive Works for the new steam chest and studs, the Lehigh Valley Railroad for furnishing the dynamometer, and the Norfolk & Western Railroad for the various yokes and rods, and the use of the valve motion indicator.

Counter-Balancing Locomotives.

E. M. HERR, W. H. LEWIS, C. H. QUEREAU, S. P. BUSH, Committee.

Your committee have formulated the rules which follow, after full consideration of the following fundamental principles:

First. The weight of the reciprocating parts that are left unbalanced should be as great as possible, consistent with a good riding and smooth-working engine.

Second. The unbalanced weight of the reciprocating parts of all engines for similar service should be proportional to the total weight of the engine in working order.

Third. Total pressure of the wheel upon the rail at maximum speed when counter-balance is down must not exceed an amount depending upon the construction of bridges, weight of rail, etc., and when counter balance is up the centrifugal force must never be sufficient to lift the wheel from the rail.

A majority of railroads answering the committee's circular leave unbalanced one-third of the reciprocating parts. In order to see how nearly this method makes the unbalanced weight of the reciprocating parts proportional to the total weight of the engine, we have plotted on Fig. 1 the relation of the unbalanced reciprocating weight on one side and the total weight of 75 road engines in actual satisfactory service on seven different roads. On the same diagram are drawn lines, all the points in which are proportional to the total engine weights laid off on the horizontal. The first line marked 1/300 is drawn through about the average of all the points plotted, and indicates that the average unbalanced weight of the reciprocating parts on one side of engine as balanced on these roads is 1/300 of their total weight. The upper line marked 1/400 represents the ratio of unbalanced reciprocating parts on one side to the total engine weight, recommended by Mr. G. R. Henderson, Mechanical Engineer of the Norfolk & Western Railroad, in an admirable report on this subject made to Mr. R. H. Soule, about a year ago and to which your committee is indebted for valuable data and suggestions. Mr. Henderson proposes the following formula for express-

ing the relation between the unbalanced reciprocating parts and the total weight of the engine:

$$Wr = \frac{Wt}{300}$$

Wr = the weight of the unbalanced reciprocating parts on one side.

Wt = the total weight of the locomotive in working order.

From the data obtainable, we believe this formula allows a greater proportion of the reciprocating parts to remain unbalanced than present good practice will warrant.

The intermediate line marked 1/400 on diagram indicates the average maximum of unbalanced weight of reciprocating parts in locomotives now in service on various roads. From actual tests of locomotives so balanced in fast passenger service, we recommend it as a safe formula for the maximum limit of the weight of the unbalanced proportion of the reciprocating parts on one side.

In formulating the following rules it is assumed that the driving wheels are finished and mounted on their axles with pins in place.

In designing new locomotives the proper counter balance weight should be calculated and cast into the wheel centers as follows: Place the center of gravity of counter-weight opposite the crank-pin as far from the wheel center as possible and have it come as near the plane in which the rods move as proper clearance will allow. To obtain weight of the reciprocating parts and detachable revolving parts, proceed as follows:

RECIPROCATING PARTS.

Take the sum of the weights of piston complete, with packing ring, piston rod, crosshead complete, and the weight of the front end of the main rod complete. Weigh each end of rod separately supported.

REVOLVING PARTS.

Weigh the back end of the main or connecting rod, and each end of each side rod complete, separately supported. The sum of the weights so found which are attached to each crank pin are the revolving weights for that pin.

RULES FOR COUNTER-BALANCING LOCOMOTIVE DRIVING WHEELS.

First. Divide the total weight of the engine by 400; subtract the quotient from the weight of the reciprocating parts on one side as found above, including the front end of the main rod.

Second. Distribute the remainder equally among all driving wheels, adding to it the weight of the revolving parts for each wheel. The sum will be the counter-balance required if placed at a distance from the wheel center equal to the length of the crank.

SHOP METHOD OF COUNTER-BALANCING MOUNTED LOCOMOTIVE DRIVING WHEELS.

Place the axle with journals upon the straight edges and level the straight edges by means of the adjustment screws. Turn the wheels until the center of one crank pin is above and exactly in a vertical line drawn through the center of the axle. Hang a yoke on the opposite pin; then add weights until the sum of the weight of the yoke and weights equals the exact weight of all the detached revolving parts on this wheel, plus the proportion of the reciprocating weights determined by rules given above. Increase or decrease the counter-balance opposite the crank pin until it exactly balances the weight thus applied. Repeat this process for the opposite wheel in the same manner.

Counter-balance weights added to old wheels should be generally cast in two parts, fitted between spokes, securely bolted, with the ends of bolts riveted over the nuts. Increased weight of counter-balance can be obtained when necessary by boring out cast iron and substituting lead, or in other ways replacing cast iron with a denser material.

CAUTIONS AND LIMITATIONS.

If we assume that the maximum speed in miles per hour of the driving wheel of a locomotive equals its diameter in inches, it can easily be shown (see appendix) that if such wheel is overbalanced by an amount W , at its maximum speed, this overbalance will increase and decrease the wheel pressure on the rail each revolution 38.4 times W , or denote such increased pressure by P , then $P = 38.4$ times W , or nearly $P = 40 W$. Therefore, in order that the wheel

shall never leave the rail, 40 times the portion of the weight of the reciprocating parts added to each wheel must not exceed its static pressure on the rail. To insure safety it should not exceed 75 per cent. of such pressure. Nor should this amount, when added to the static wheel pressure, exceed the safe maximum pressure allowed on track and bridges. Locomotives with rods disconnected and removed should not be hauled at high rates of speed.

Make reciprocating parts as light as possible.

Spread cylinders as little as possible.

The committee recommends that a number of roads be selected to try the rules outlined, and report result of the trial before the convention of 1897; and that the committee be continued until that time, when, if the practice is found satisfactory, it can be adopted as standard.

APPENDIX.

We take the following from Mr. Henderson's report:

"To determine the centrifugal force, we have from Weisbach, Vol I., page 609, the following formula:

$$P = .0034 U^2 G R$$

U = revolutions per minute.
 G = weight in lbs.
 R = radius in feet. Now let
 s = speed in miles per hour;
 d = diameter of wheel in inches, then

$$U = \frac{s \times 5280 \times 12}{3 \times 1416 \times d \times 60} = \frac{s \times 1056}{d \times 3.1416} = 336 \frac{s}{d}$$

and

$$U^2 = 112896 \frac{s^2}{d^2} \text{ and, substituting, we have,}$$

$$P = 38.4 \frac{s^2}{d^2} G R \quad \text{and where } R = 1,$$

$$P = 38.4 \frac{s^2}{d^2} G$$

If we assume that the speed in miles per hour at its maximum equals the diameter of the wheel in inches, we have simply

$$P = 38.4 G, \text{ or say, } P = 40 G.$$

Steps and Handholds.

JOHN MEDWAY, H. BARTLETT, J. T. GORDON, F. M. TWOMBLY, G. H. BAKER, Committee.

The majority of those answering the circulars of the committee are in favor of a wide double step on the front corners of the tender frame and long vertical grab irons, or handholds, on the front corners of tanks, on the back of cabs and in connection with the cab brackets. A few persons favor a wide step on the back corners of engines also. The form of steps used extensively on modern locomotives usually contains too deep an opening in the riser. This feature the committee considers an element of danger in that the foot is liable to slip through. They recommend that the distance between the tread and opening be not less than five inches. The step recommended by them is shown in Fig. 1. They do not advocate steps at the back corners of tenders. For switching-engines they recommend long steps suspended transversely from the back of the tender frame. The step should have a back guard to prevent the foot from slipping through. It should be made and applied in a substantial manner and set at the uniform height of 12 inches from the rail. Care should be taken to leave an opening between the tread and riser sufficient to dispose of ice and snow, but not large enough to admit a part of the foot. In connection with this

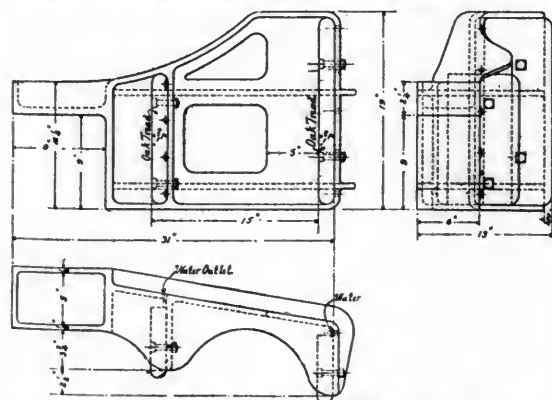


Fig. 1.—Recommended Tender Step.

step, a long, horizontal hand-rail should be placed at a convenient height. On road engines various kinds of steps or ladders are used with which to reach the top of tank at back.

Headlight steps should have a roughened tread and flanges on the sides, and should be applied to the smokebox at a convenient point between the steam chest and headlight. A supplemental hand rail should be provided, and sometimes a pilot step is necessary. But the details must be governed by conditions that vary too

much to permit of a general rule. To reach sand boxes, steps similar to those on the smokebox are satisfactory.

In conclusion, the committee is of the opinion that to insure comparative safety the form and location of locomotive steps and handholds should be so nearly uniform that in mounting or alighting one could, even in the dark, readily locate with his feet and hands all the steps and handholds of any locomotive.

Cylinder Bushings.

J. N. BARR, J. H. MCCONNELL, J. S. CHAMBERS, GEO. F. WILSON, W. H. MARSHALL, Committee.

The conclusions of this committee are summarized as follows:

First. That cylinder bushings $\frac{1}{8}$ inch to $\frac{1}{4}$ inch in thickness will meet all requirements.

Second. The bushings should be turned to the same diameter as the cylinder fit.

Third. Bushings of a uniform outside diameter and extending from the back to the front cylinder head, or bushings extending from the back steam port to the front head, the bearing surface of the cylinder heads resting partly on the end of the bushing and partly on the cylinder proper, without any fastening except the pressure of the heads, will give perfectly satisfactory results.

Fourth. The use of bushings is a practical method of reducing the bore of cylinders, of repairing cracked and worn cylinders, and avoiding the difficulty of cylinders which are too soft.

Fifth. The question of fuel and oil economy, which may be obtained by the use of hard, homogeneous bushings, is one which should receive careful attention.

Those recommending the use of bushings for new cylinders do so on the following considerations: The qualities required in a cylinder casting in order to withstand the strains to which it is subjected are especially strength and toughness. These two qualities are, however, inconsistent with the hardness that is necessary to secure a good, smooth polish in the bore of the cylinder. In the attempt to obtain a good wearing surface in the cylinder, the casting has a tendency to become of such a character as is liable to crack in service.

By the use of an independent bushing a perfectly clean casting of uniform density throughout, and of such a hardness as will give the best results as to wear can be obtained without in any manner influencing the quality of the material in the body of the cylinder.

It should be borne in mind that frictional resistance between the cylinder and the piston consumes a large amount of power, and any means which will reduce this resistance is likely to produce a freer working engine, and one more economical in consumption of fuel and oil.

Some members of your committee are decidedly of the opinion that the advantages gained by using a brushing harder than it is possible to obtain in the ordinary cylinder casting effect a decided economy in the above respects.

In this connection your committee desire to call attention also to the matter of false valve seats. If these are cast separately, they can be made much harder than the ordinary solid seat. The false seats are now constructed in such a way as to give practically no trouble, and with the adoption of the false valve seats, and a cylinder bushing of the proper hardness, the entire wearing parts of the cylinder would be fully provided for, and the failure of the cylinder would simply depend on its power of resisting the strains to which the body is subjected in service.

Standard Size of Boiler Tubes.

WM. SWANSTON, Committee.

The committee recommends that the standard specifications for locomotives iron boiler tubes be changed to conform to the decimal gage of the association and to allow additional thickness at the weld by being made to read as follows: Under the head "Dimensions and Weight."

TUBES 2 INCHES OUTSIDE DIAMETER.

.095 inches thick and weight at least 1.01 pounds per foot.	
.110 " " " "	2.19 " "
.125 " " " "	2.47 " "
.135 " " " "	2.65 " "

TUBES 2 1/4 INCHES OUTSIDE DIAMETER.

.095 " " " "	2.16 " "
.110 " " " "	2.48 " "
.125 " " " "	2.80 " "
.135 " " " "	3.01 " "

Under the heading of "Surface and Inspection," "and must be of uniform thickness throughout, except at the weld, where one gage number additional thickness will be allowed" be changed to read "where .015 inches additional thickness will be allowed."

The committee urges strongly the importance of using the decimal gage in ordering all kinds of material for which it was designed and adopted by the association.

Driving Box Wedges.

J. DAVIS BARNETT, H. A. CHILDS, T. J. HATSWELL, R. ATKINSON, R. E. READING, Committee.

The replies to the circular of inquiry issued by this committee only numbered 49, but of those answering, a decided majority are in favor of wedges that cannot be adjusted on the road. The data presented to the committee by members was unsatisfactory and the committee says that the strongest point the replies justify them in making is that those who dispense with movable wedges do not go back to them.

MASTER CAR BUILDERS' ASSOCIATION.

ABSTRACTS AND SUMMARIES OF REPORTS
PRESENTED AT THE THIRTIETH
ANNUAL CONVENTION.Axle, Journal Box, Bearing and Wedge for Cars of 80,000
Pounds Capacity.

E. D. NELSON, J. H. RANKIN, GEORGE GIBBS, WILLIAM FORSYTH,
JOHN HODGE, J. E. SIMONS, F. W. CHAFFEE, Committee.

The larger part of the report has been devoted necessarily to the axle, not only because it was essential first to decide upon its design before the journal box, wedge and brass could be considered, but because it was realized that there were two limits between which it was necessary that the design should fall. The first of these was that the limit for strength should, unquestionably, leave no doubt as to the safety of the design. The breaking of a car axle is becoming daily a more serious matter. On double track roads it involves not only the safety of the train in which it may fail, but of both passenger and freight trains on the opposite track. Evidence of the seriousness of this matter is only too easily obtained. The other limit was that of cost. To meet these ends has been the aim of our committee.

The plan of the report is to discuss first theoretically the matter of strains in the axle, in which is included from practical information the important element of vertical oscillation on the springs. The question of fiber stress is then considered, and following this is a discussion of the journal proportions from the standpoint of friction and lubrication. Conclusions having been reached under these heads the design of the axle naturally follows, with specifications for the material to be used. Reference to the designs for journal box, wedge and bearing will be found in the concluding paragraphs.

Next follows a complete analysis and calculation of the strains in an axle resulting from all the forces acting on it, Reuleaux's method being employed. These calculations are compared with a second set computed by the method of Wohler, which is based largely on experimental data obtained with four-wheeled cars on Prussian railways. We have not the space to devote to these excellent mathematical demonstrations, but must refer our readers to the report itself. One interesting experiment in this connection, however, we record. To apply the calculations to practice, it was necessary to know how much the static load on the axle was increased by the vertical oscillations of the car on its springs. Wohler states, from his experiments with four-wheel cars on the Prussian State railways, that the weight on the journal is increased three-eighths by the force due to vertical oscillation. As this was determined by experiments in four-wheel cars and on railroads in Prussia the committee endeavored to confirm this figure by experiments on American railways and with eight-wheel cars.

The method employed was as follows: A car fitted with Fox trucks was selected, the box springs taken out, and each spring was carefully calibrated, to show the force necessary to compress it each one-eighth of an inch from the height of spring free to the spring when down solid. Each spring was then fitted with a simple recording apparatus, shown in Fig. 1, intended to register the maximum compression of the spring in inches, and the springs were replaced in the trucks.

A piece of $\frac{1}{2}$ -inch gas pipe *C* was finished outside and slotted longitudinally at *B* and fitted in the hole *A* drilled through center of spring cap, and having sufficient friction so as not to be moved by any jolting of the truck.

Any compression of the spring caused the pipe *C* in contact with the boss *D* on the journal box to be forced upward into the hole *A*, where it would remain, thus registering the compression of the spring.

The car was a box car of 60,000 pounds capacity and was loaded to 67,000 pounds; the light weight was 34,400 pounds; the total being 102,200 pounds; the total weight of wheels, axles, boxes, brasses, etc., was 7,848 pounds; this deducted from 102,200 pounds leaves 94,352 pounds as the weight above the springs, which divided by 4 gives 23,588 pounds as the weight on each axle above the springs, or 11,794 pounds on each spring, due to the static load.

The car was then run from Renovo, Pennsylvania, to Canandaigua, New York, over the lines of the Pennsylvania Railroad, and back to the starting point, a distance of 308 miles. The springs were then removed and again calibrated, in order to check the former figures found, made before the car was started. The springs were also measured at the Altoona physical testing laboratory, to confirm the measurements made with the shop apparatus employed. The maximum compression of each spring was found from the recording apparatus, which was placed over each box.

The average maximum compression of the eight springs was found to be equal to a load of 19,460 pounds on each spring. The maximum compression for any one spring was found to be 23,463 pounds. From these figures it is proposed to deduce the value of the force due to vertical oscillation of the car on the springs.

If the maximum horizontal force acting on the car be taken as 40 per cent. of the static load and the center of gravity of the loaded car be 72 inches above the rail, calculation shows that in the case of the car tested the maximum load on one journal was 18,573 pounds, without considering the effect of vertical oscillation on the springs.

It can be proved that if the center of gravity of the car is 72 inches above the rail, that 40 per cent. of the static load acting horizontally will almost entirely relieve the weight on one rail. In other words, the assumed value of the horizontal force is very nearly sufficient to turn the car over. Hence we may consider the

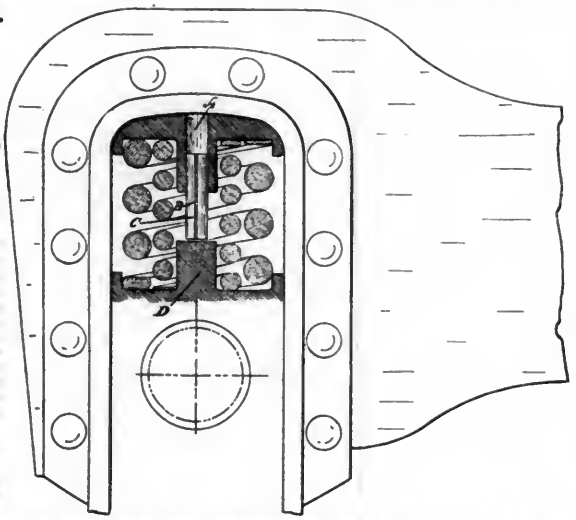


Fig. 1.—Apparatus for Determining Vertical Oscillation of a Car on Its Springs.

assumed value as a maximum, and with this assumption our calculation gives 18,573 pounds as the maximum compression on one spring due to that force and the static load. But the maximum compression on one spring by experiment was 23,463 pounds, and consequently the difference between these two amounts may be regarded as due to vertical oscillation of the car on the springs. This is not necessarily the actual vertical oscillation, but it may be considered as the maximum vertical oscillation when the horizontal force is taken as a maximum. This difference is 4,890 pounds. This is equal to 41 per cent., nearly, of the static load on each journal, which was 11,794 pounds. As formerly stated, Wohler found by experiment that the force due to vertical oscillation was $\frac{3}{8}$ or 37.5 per cent. of the static load on each journal, so that the amount as found in the experiment made by the committee agrees closely with his results.

The formula for the moment of the forces at the hub and at the center when the axle is mounted on 33-inch wheels is by Reuleaux's method found to be as follows:

$$M = \frac{Wb}{2} - \frac{Hh}{m}(x-b) + \frac{Hh_1x}{l} + Hh_2 + \left(\frac{W}{2} - \frac{Hh}{m}\right)h_2 \tan \alpha \quad (1)$$

where

W = the total vertical pressure on the axle, including allowance for vertical oscillation.

H = horizontal force caused by curves, switches and wind pressure.

h = height of center of gravity of car above top of rails.

*h*₁ = height of center of gravity of car above center of axle.

*h*₂ = height of center of axle above top of rails.

l = length of axle between points of application of total load *W*.

m = distance between center of rails.

b = the distance from center of rail to point where load on journal is assumed to act.

x = any distance along axle from point where load on journal is assumed to act.

α = angle between head of wheel and the horizontal.

According to Wohler's method the formulas are as follows:

For the hub

$$M = .176 Wb + .516 W + 322.245 \sqrt{W} + 4.125 H$$

and for the center

$$M = .176 Wb + .516 W + \frac{1}{4}(322.245 \sqrt{W} + 4.125 H)$$

where *M* = the moment of the forces,

W = the total weight above the springs,

H = the horizontal force,

b = distance from center of rail to point where journal load is concentrated.

The diameters at the hub and at the center may be calculated by the well known formula

$$d = \sqrt[3]{\frac{M}{.09827}}$$

where *M* = the moment of the force,

f = the fiber stress,

d = the diameter of the axle.

These formulas suffice to determine the dimensions between the wheels when the maximum allowable fiber stresses are decided upon.

The committee have in these general formulas taken into consideration all the forces acting upon that portion of the axle lying between the wheels, except the force due to impact or percussion. This latter is confined entirely to the journal and that portion of the axle lying outside of the wheel, and is not communicated to that part of the axle lying between the wheels, because in order to have any force applied at the journal produce a bending of that portion of the axle lying between the wheels it is necessary that the part of the wheels in contact with the rails should move toward each other, and that the tops of the wheels should at the same time move away from each other. The resistance to this movement

would be the inertia of the mass of the wheels themselves, and also the friction of the wheels when sliding inwardly on the rails if such movement took place. The force of impact would not take place over a sufficiently long interval to allow any effect upon the axle between the wheels. Wohler states that the portion of the axle lying outside of the wheels can only be determined from practical considerations.

We have determined how the diameter at the center of the axle and at the hub may be found. Now if we consider the weight acting at a point in the journal, the form of the axle from that point to the wheel fit, in order to have it of uniform strength, would be a parabola. This is within the dimensions necessitated by running the wheel fit out cylindrically and providing proper diameters for the dust-guard seat and journal. Hence the margin of strength in the journal and dust-guard seat is much above that taken for the hub and center.

FIBER STRESS.

Under this head the committee first takes up the natural limits of elasticity. When testing was first employed to determine the nature of a material, it was quickly noticed that when the specimen was loaded or bent beyond a certain point it would not recover its original dimensions or shape upon the removal of the load. The limiting stress or straining, below which no permanent effect upon the specimen could be noticed, was called the "elastic limit." It appeared obvious to experimenters that since the specimen recovered completely its original form and dimensions, it had not been injured, and it would be safe to apply any loads within the elastic limit indefinitely without any injury resulting.

Subsequent practical experience, however, proved that under the conditions of repeated reversals of stress it is not safe to subject a bar to a strain anywhere near the elastic limit, as determined in the testing machine.

According to Wohler, who spent some 12 years at the instance of the Prussian Government in experimenting upon the effect of repeated stresses in small bars, the outer fiber stresses, where the strains alternated between tension and compression, he found might be safely taken as 17,000 pounds per square inch for iron and 23,000 pounds per square inch for steel, without limiting the life of the bar, but if the stresses exceed these limits, fracture would always occur if the number of repetitions of stress were sufficient. This is a stress of approximately $\frac{1}{2}$ the tensile strength of the material, and is considerably within the elastic limit as ordinarily determined.

In large bars, such as car axles, where the extreme or outer fibers are a considerable distance from the neutral axis, and where the material is often far from homogeneous throughout, it is reasonable to suppose that strains are not transmitted symmetrically in all its parts and some of the fibers may bear a larger proportion of the total stress than would occur in even distribution. In this way the elastic limit may be locally exceeded with a very moderate total stress only.

From all evidence it seems reasonable to conclude that a material will not be injured if strained repeatedly any amount within its natural elastic limit; that the so-called "fatigue of metals" may be noticed if strains are in excess of this natural elastic limit, and still within the elastic limit as ordinarily determined; that there is a possibility of the natural elastic limit being exceeded at points locally within the structure of a large mass by a moderate total strain, thus starting local cracks which will extend to the ultimate destruction of the piece.

As to the effect of temperature, it seems to be pretty well established that the effect of ordinary atmospheric changes of temperature, say, from 20 degrees below to 120 degrees above zero Fahrenheit, upon the physical properties of iron and steel, are slight and unimportant when stresses are applied without shock. But the effect of a change of temperature upon the ability of these metals to resist shocks is not so definitely known.

Mr. Thomas Andrews, in a paper read before the Institution of Civil Engineers, 1887, gave results of tests by impact under a drop hammer, of forty-two full-size iron axles, the axles having been heated and cooled to various degrees, for the purpose of determining the effect of temperature upon strength.

He found that at 100 Fahrenheit the axles were 43 per cent. stronger than at 7 degrees, and concludes that low temperature materially reduces the power of resistance of railway axles to continued heavy impact.

It is to be doubted, however, whether these tests throw much light upon the effect of temperature upon axles as stressed in service, since the shocks in his method of tests were altogether more severe than those met with in service, from six to eight blows being sufficient in each case to break the axle. In fact, experience in this country shows that few, if any, more axles are broken in cold weather than in warm, and it is reasonable to assume that the greater rigidity of the road-bed in winter would fully account for any greater percentage of breakage in that season than in summer. Carefully kept records of axles broken or bent on one of the largest railway systems in this country show that no larger number of axles failed in the colder months than in the warmer ones.

Your committee would consequently offer the opinion that temperature need not be taken into account in determining the design of axle; but that with more definite information it may be advisable that certain limit for variation of temperature should be established as standards for use in testing axles under the drop.

It has been stated that Wohler found that for an unlimited number of reversals of strain, the fiber stress may safely be taken at 17,000 pounds per square inch for iron and 23,000 pounds per square inch for steel. But as his experiments were made with small specimens, and as axles are subject to various stresses, apparently not included in his investigations, it would seem best to look into the fiber stress of axles in service and see what can be learned. The method of Reuleaux, already given, can readily be utilized to determine the fiber stress of any given axle. It is only

necessary to find the moments and from the actual diameters find the fiber stress.

Your committee has followed this method for axles already in use, where they have been in service a number of years, and where the number of axles has been sufficient to justify safe conclusions by such an analysis.

Taking the fiber stress calculated in this way it was found that a large number of axles had broken of one design where the fiber stress was 28,000 pounds, these axles having been in service from four to nine years. Where the fiber stress was 23,000 pounds and less, the records show that axles have been practically free from failure by breaking.

The fiber stress of 28,000 pounds was found approximately the same at the wheel seat and center, and the records showed that breakage took place at both of these points.

Furthermore, the axles with the lower fiber stresses, and which have not broken, show that for the strains found by Reuleaux's method the fiber stress is approximately uniform between the wheels.

Your committee has concluded, therefore, that if the new axle is designed, using the strains as found by Reuleaux's method, and if a fiber stress of 22,000 pounds per square inch is taken for the portion of the axle between the wheels, and the material provided in the specifications is used, a safe design will be the result without much surplus material.

Concerning the fiber stress in journals, this portion of the axle is subjected to strains of a more complicated nature, and the results of experience will be the safest guide.

From an examination of the fiber stress in journals which have broken and which have not broken, it is concluded that, for the diameter attained when the journal is worn to its limit, the fiber stress for static load should not exceed 11,500 pounds per square inch. It would be safer to keep it close to 10,000 pounds per square inch, which figure has been adopted for the diameter when it has reached the limit of wear.

From the diagram, Fig. 2, the fiber stress in a 5 by 9-inch and $4\frac{1}{2}$ by 8-inch journal when new, worn, and worn to limit, can be found for any load from 9,000 pounds to 35,000 pounds. The load W is applied at a distance J from the shoulder of dust-guard seat. The value of J is $5\frac{1}{2}$ inches for a 5 by 9-inch journal, and $5\frac{1}{2}$ inches for a $4\frac{1}{2}$ by 8-inch journal. The lever arm T for moments is shown in each on the diagram and is taken from tangent of circle at fillet to point of concentration of load W .

It will be seen that the stress under a static load of 15,500 pounds, is, for a new axle with a 5 by 9-inch journal, 6,300 pounds, and when worn to limit, $4\frac{1}{2}$ inches in diameter, it is 10,200 pounds. A new axle with $4\frac{1}{2}$ by 8-inch journal, with a static load of 11,000 pounds,

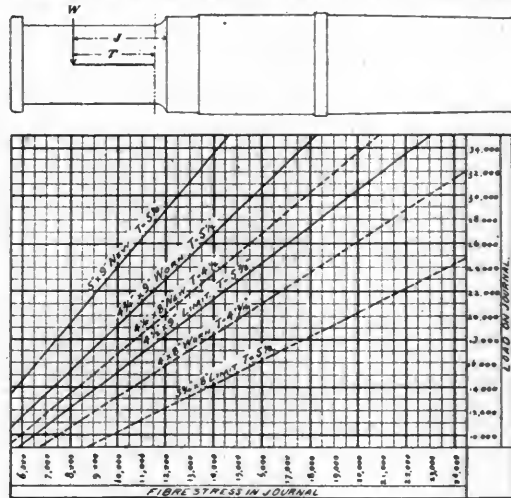


Fig. 2.—Fibre Stresses in 5" x 9" and $4\frac{1}{2}$ " x 8" Journals.

would have a fiber stress of 6,500 pounds when new and 10,800 pounds when worn to the limit of $3\frac{3}{4}$ inches in diameter.

The stress in the journal due to any assumed maximum load may thus be found direct from the diagram.

THE JOURNAL—FRICTION AND LUBRICATION.

Considering the proportions of the journal with respect to friction and lubrication, the principal figure desired is the maximum pressure per square inch which can be placed on freight car journals without undue friction, wear of bearing and liability to heat.

Laboratory experiments made in this country and Europe do not give any satisfactory data on this subject, and we are compelled to assume that the $4\frac{1}{2}$ by 8-inch journal is satisfactory for cars of 60,000 pounds capacity, and determine from this the pressure per square inch to be allowed on the new journal. Fig. 3 is a diagram showing the method of determining the area of bearings.

The chord of a new bearing $4\frac{1}{2}$ inches in diameter is 3.56 inches, and, leaving out fillets, the length is 6.3 inches, and its area 24.48 square inches. Under a loaded car, allowing 10 per cent. overload,

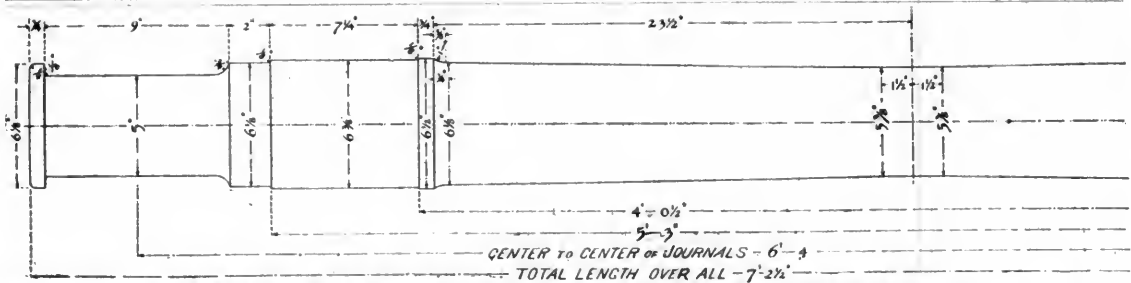


Fig. 4.—Axle to Carry 31,000 Pounds. (For Use Under Cars of 80,000 Pounds Capacity.)

the weight on one journal is 11,000 pounds, and the pressure per square inch is therefore 449 pounds. When the journal is worn down to its limit of 3 1/4 inches in diameter, the chord is 3 inches, the area is 20.63 square inches, and the pressure per square inch is 533 pounds. If a bearing bored for 4 1/4-inch journal is placed on a journal worn to 3 1/4 inches in diameter, the chord of the arcs in contact is less than 1 1/2 inches. Taking this figure, 1 1/2 by 6 3/4 inches, we have an area of 8.59 square inches, which must carry its share of the weight, and which under a fully loaded car amounts to 1,280 pounds per square inch.

The fact that bearings run some time before they increase the bearing surface to double the amount assumed leads us to believe that it would be safe to proportion a car journal for a load of 600 pounds per square inch.

Professor Denton's experiments on car journals, under very heavy pressures, showed that they might be run under a pressure of 5,000 pounds per square inch, and that the rapid wear would soon increase the area of bearing, and with a pressure of 1,000 pounds per square inch on a polished journal a coefficient as low as 0.11 per cent. has been obtained.

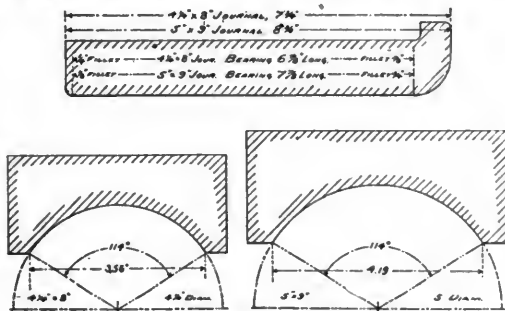


Fig. 3.—Showing Journal Bearing Areas.

For the axle designed to carry 31,000-pound stresses under the maximum load, as has already been seen, would require the journal to be at least 4 1/4 inches in diameter; adding 1/4 inch for wear it would be 5 inches in diameter; and if we make its length 9 inches and the bearing 3/4 inch less, by leaving out fillets we get the length of effective bearing as 7 3/4 inches. Taking the same angle of contact as the 4 1/4 by 8-inch bearing, the length of chord would be 4.19 inches, and the bearing surface of a new journal would be 33 square inches. Taking 15,500 pounds as the load on journal, we have a pressure of 469 pounds per square inch. When worn to 4 1/4 inches diameter the chord would be 3.75 inches and the area consequently 29.53 square inches. This gives 525 pounds as the pressure per square inch.

In our final calculations we have assumed the probable maximum conditions for concentration of the load on journal, which would be when the collar of the journal is worn to 1/4 inch in thickness from contact with the brass and the brass worn off 3/4 inch on the end next to the collar of the journal. This occurs when the horizontal force previously explained is at its maximum.

DESIGN OF AXLE—REULEAUX'S METHOD.

Having prepared the general methods to be followed and determined the necessary data, we may take up at once the design of the axle. The committee was instructed to design an axle for an 80,000-pound-capacity car, but concluded that the capacity of the car is not a proper measure of the weight carried by the axle.

We will therefore determine for an 80,000-pound-capacity car what would be the maximum weight on each axle, and it should then be understood that the design of axle submitted in this report is one designed to carry that weight, and not an axle for an 80,000-pound-capacity car, regardless of the weight of the car body and trucks. We may assume for the probable weights of 80,000-pound-capacity cars the following:

Gondola car.	
Weight of body and trucks.....	35,600 pounds.
Lading.....	80,000 "
Twenty per cent. additional lading.....	16,000 "

	131,600 pounds.
Deduct weight of wheels and axles.....	7,600 "

or 31,000 pounds per axle.

Refrigerator car.	
Weight of body and trucks.....	43,600 "
Lading.....	80,000 "
Ten per cent. additional lading.....	8,000 "
	131,600 pounds.
Deduct weight of wheels and axles.....	7,600 "
	124,000 pounds.

or 31,000 pounds per axle.

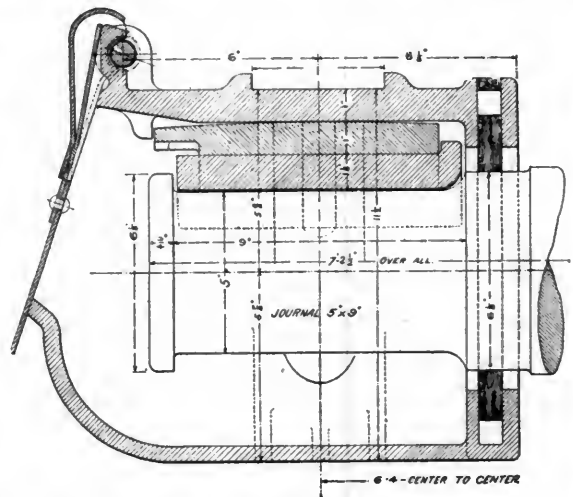


Fig. 5.—Journal Box Complete for 80,000 Lbs. Cars.

NOTE—Distance between bolt centres equals 9 inches.

The axle recommended by your committee is therefore designed to carry 31,000 pounds, including body, trucks and lading. It should be distinctly understood that the axle recommended is to carry this weight, as the sum of the weights of the car body and trucks and lading when using 33-inch wheels.

On the basis of 31,000 pounds static load on the axle and a maximum fibre stress of 22,000 pounds the required diameter of the axle at the hub is found by Reuleaux's method to be 6.21 inches and at the center 5.30 inches; or taking the nearest 1/4 inch for convenience, 6 1/4 and 5 3/4 inches, respectively. To the diameter at the hub it is necessary to add 1/4 inch to provide for reduction of diameter when fitting axles to wheels as allowed in the interchange rules; hence the diameter at the hub becomes 6 3/4 inches. Wohler's method would give a less diameter at the hub and greater at the center, but the results of Reuleaux's methods are taken as the better.

DESIGNS FOR AXLE, JOURNAL BOX, WEDGE AND BEARING.

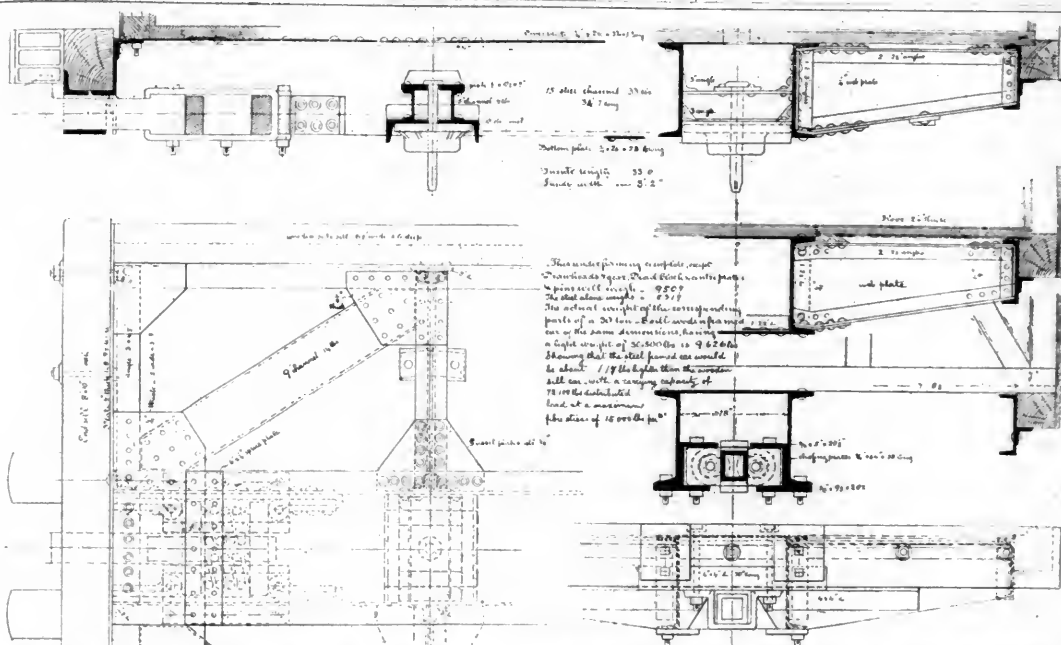
In Fig. 4 is given the design of axle to carry 31,000 lbs.

It will be noticed that the axle is cylindrical for a distance of 3 inches at the center, in order to get rid of the angle at the center. The fillet at outer end of journal is made as small as possible without getting a sharp corner, and still making it easy to obtain in ordinary shop practice. The fillet at back end of journal is made large to prevent the rapid wearing to a small fillet at this point.

Fig. 5 shows the journal box and the contained parts in position. The general design of the M. C. B. journal boxes, already adopted by your Association, has been followed, except that the bottom of the box has been rounded in order to eliminate the corners and to concentrate the oil below the center line of journal, where it has the greatest opportunity to be drawn into the packing.

[Separate drawings of the box, wedge, bearing and lid are shown, but are not reproduced.—Ed.]

In another drawing (not reproduced here) is given a portion of the same journal box, except that the face of box has been changed to suit the Fletcher lid. This form of lid has so many advantages that your committee decided to ask consideration of



Steel Underframe for 30-Ton Freight Cars—Designed by R. P. C. Sanderson, Asst. Supt. Motive Power, Norfolk & Western Road, and C. C. Wentworth, Chief Engineer, Virginia Bridge Works.

it as compared with the form of lid already adopted for cars of less capacity.

SPECIFICATIONS.

A set of specifications for iron and another for steel axles accompany the report. They go into minute details and would occupy too much space to be printed here. A summary of the steel-axle specification is as follows: The axle must be free from physical defects that can be detected by the eye. It must be rough-turned all over with a flat-nosed tool, except for a short distance just inside of each wheel fit. The composition of the steel must conform to the following:

Carbon	0.40 per cent.
Manganese, not above	0.50 "
Silicon	0.05 "
Phosphorus, not above	0.05 "
Sulphur, not above	0.04 "

All axles must be stamped with name of maker and the blow or heat number. Axles from any one heat must be kept together for inspection. At least 30 axles from each heat must pass the physical inspection. Then one axle from each heat passing this inspection will be subjected to physical (drop) test. The drop test must be carried out on a machine with a spring-supported anvil similar to that illustrated in the *American Engineer* for April, 1896. The anvil is to weigh 17,500 pounds; the drop weight, 1,640 pounds. Each axle must stand five blows from a height of 43 feet, without rupture or fracture. A deflection is desired of not more than $5\frac{1}{2}$ inches, after the first blow, and a deflection of more than $6\frac{1}{2}$ inches will cause rejection. Axles will be rejected if the chemical test shows:

Carbon	below 0.35 per cent. or above 0.50 per cent.
Manganese	0.60 "
Phosphorus	0.07 "

The specifications for iron axles call for double-worked forged scrap, into the center of which 80 pounds of new bar iron can be worked if desired. They must not show any seams having a clear opening of $\frac{1}{8}$ inch or more, and being more than 1 inch long. From each 101 axles, one will be taken for test. The drop test which it must pass is the same as for steel, except the five blows are from a height of $23\frac{1}{2}$ feet.

Metal Underframing for Freight Cars.

R. P. C. SANDERSON, J. D. McILWAIN, J. R. SKINNER, JOHN PRAYER, Committee.

With the gradual and steady increase in the carrying capacity of freight cars and in the hauling power of freight locomotives, the insufficiency of the earlier methods of freight-car construction, developed from wagon building, consisting of timber framing held together by nails, spikes, straps, lag-screws and bolts, became more apparent.

The lessons learned on the repair tracks led to the strengthening of freight-car body bolsters and longitudinal sills with truss roads, and, finding this to be still insufficient, the timbers have been reinforced with iron and steel as in the well-known fitch-plate

bolster, or in the fairly effective plating of bolsters, end and longitudinal sills.

Some designers, recognizing the inherent weakness in any composite form of construction where wood is used, went at once to iron for body bolsters, of which there are numerous designs of the built-up type. Here should also be mentioned the Schoen pressed steel, American and Shickel, Harrison & Howard cast-steel body bolsters, which have been extensively illustrated in the technical journals and are well known to the members.

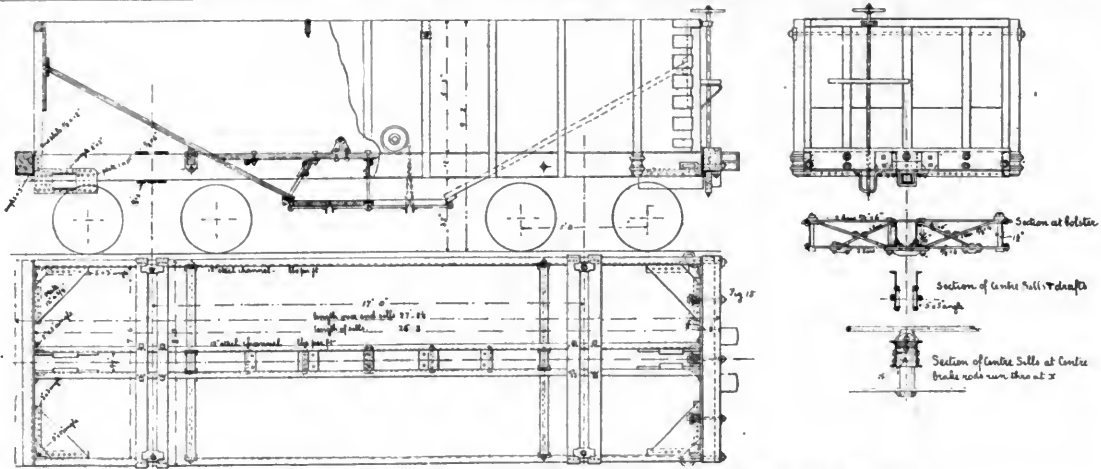
The Chicago, Burlington & Quincy Railroad car (See *AMERICAN ENGINEER* for March, 1896) marks a long step ahead in that the center sills, as well as the bolsters, are of steel. It is very probable that the use of iron and steel in car construction would have advanced far beyond its present standpoint but for prejudice which has grown up in the minds of many against any and all iron or steel cars, as the result of some unfortunate ventures in which the designers either did not fully understand the service and strains a freight car has to withstand, or from lack of experience, and in an endeavor to keep the weight and cost of their cars down to limits which would enable them to make sales, placed cars in service that have become a by-word on account of their frequent and prolonged sojourns on the repair tracks.

It would be quite as unjust to condemn all iron or steel car construction on account of these failures as it would be to condemn the use of wood in car construction because some of the earlier builds of cars, and even some comparatively recent designs, are so poorly proportioned that they are constantly failing. The obviously proper course is to profit by these early failures in iron car construction, make use of the experience gained and go on with the development of the steel car frame, trying to avoid the errors of the past. It is only necessary to remind those present of some of the exhibits at the Chicago Exposition to show that progress has been made in the right direction.

Even if the members of your committee felt that they could present a design for standard steel framing for freight cars which would be practically perfect and require no future modification (which is not the case), it would not be practicable to do so until greater uniformity in the lengths and sizes of interchange freight cars for given capacities has been brought about. It is to be hoped that a thorough inquiry into the subject will be made by the Association by means of a committee to recommend standard lengths of sills and widths over sills for refrigerator, box, stock, flat, drop-bottom and drop-end gondola cars of 60,000, 70,000 and 80,000 pounds capacity, and that the Association will adopt such standards.

After this step has been taken, then, with sufficient experience and knowledge to guide them, a committee could take up the subject of steel underframing for freight cars, and, with good hope of success, present to the Association a series of designs for M. C. B. steel underframes that could be adopted and used, as far as their general features are concerned, without fear of serious failure ensuing.

As long as the main framing of foreign freight cars coming on our repair tracks is of timber (which can be cut and dressed to suit by the ordinary carpenter's tools), and of iron truss-roads and bolts (which can be cut or welded by any blacksmith), odd sizes of sills, etc., are not such a serious matter, but when we come to steel and iron, which



Steel Framed Hopper Car of 60,000 Lbs. Capacity—Norfolk & Western Railroad.

Total light weight of car 29,800 lbs., or 1,500 lbs. more than weight of same class of cars with wooden sills.

require heavy machine tools and shop treatment, and where odd sizes or shapes must be specially ordered or rolled or forged at the forges or mills, the question of uniformity of sizes becomes one of paramount importance.

With standard lengths, depth, width of flange and weight per foot for sills of all flat-bottom cars of 60,000, 70,000 and 80,000 pounds capacity, the rolling mills can carry the stock ready for instant shipment, feeling safe that they will not have it left on their hands as obsolete stock; the sills and shapes in stock at any railroad shop store would be certain to suit any foreign car that might come on the repair tracks, only requiring that the holes, etc., should be laid off and punched or drilled to suit the details of the particular car, but before this happy state of things can be brought about, the standards for lengths and widths of cars must be adopted, and—when steel-framed cars are built—rigidly adhered to.

Pending the adoption by the Association of the standard lengths and widths for given capacities, your committee present the following rules or recommendations, which they feel justified in asserting should be seriously considered by designers of steel framing for freight cars.

First. Especially forged, pressed or rolled shapes, cast steel, etc., or patented forms of construction are undesirable for cars to be used in general interchange business, no matter how well designed theoretically, for the reason that when such parts are damaged there must necessarily be long delays in ordering and obtaining these special parts, and should the parties who have furnished them go out of business, or change their molds or patterns, the parts cannot be duplicated for repairs except at enormous expense and loss of time.

Second. Steel and iron bars and shapes of standard bridge specifications and regular market sizes should be generally preferred, so that railroads and car builders can avail themselves of the competition in the open market when purchasing, or if not equipped to put steel frames together themselves, can have this work done for them at any of the numerous bridge-building concerns on competitive bids. The underframes, riveted or bolted together, can be shipped by carload lots to the car shops to be completed into finished cars.

Third. Get-at-ability in the design is of the greatest importance in keeping down the first cost and maintenance; parts that are to be riveted together should be so arranged that they will be equally convenient for hydraulic or power riveting when the car is being built, or for field riveting in repair work.

Fourth. In designing riveted work, it should be laid off with plenty of rivets, these to be spaced close, as in boiler work, and the same care to insure true fair holes, hot rivets, well driven and completely filling the holes, as in first-class boiler work, is necessary. Complaints sometimes heard against riveted work in car frames and tender frames, on account of loose rivets, can be directly traced to an insufficient number of rivets and poor riveting.

Fifth. If bolts are used to hold iron or steel parts in position, not merely to carry weight, they must be turned bolts (a driving fit), in carefully reamed holes, fitted with the greatest care. When so fitted they will probably give no trouble from working loose, but as this is machine-shop work, such bolts should be avoided as far as possible, as it is not likely that such bolts will be fitted in this way on the repair tracks, while it is reasonable to expect that a hot rivet, well driven, can be put in anywhere with the aid of a portable forge. In both riveted and bolted work it is of the utmost importance to perfectly fill the holes, remembering that it is the "initial wiggle," if only 1-1000 part of an inch, that will surely produce loose rivets and bolts and oblong holes; no amount of hammering on the heads of riveters tightening up nuts or bolts, or the use of lock-nuts, nut-locks or fibrous washers will be of any use if the holes are not perfectly filled.

Sixth. Every structure has a foundation, every machine has a bed-plate, every animal, bird, fish, and most of the higher works of nature, have a backbone or spine on or around which the structure is framed; this cardinal principle of design seems to have been

largely overlooked in freight-car construction, and it is believed that the center sills of a freight car should be made its main strength and reliance, and that the entire load shall be carried from the platform, the upper works being simply arranged as a housing to confine and protect the load.

Seventh. To enable the center sills to withstand collision and severe shocks to the best advantage, these sills should be spaced so that they will be directly in line with the dead blocks, and thus take the buffing and collision shocks in direct compression. Also their depth should be such that at least the center line of draft and centers of the dead blocks will be within the vertical dimensions of the sills. When so arranged there will be no tendency from shocks or pulling strains to bend the center sills, either laterally or vertically, or to bend or break the end sills.

Eighth. That care should be taken to avoid punching or drilling holes in the flanges of channels or I-beams where these are subject to heavy strains, especially tension or bending strains, unless additional material is added to compensate for this.

Ninth. That with the change from wood to steel the necessity for truss rods no longer exists for cars of reasonable lengths, but that ample and sufficient strength can be obtained within reasonable limits of weight without the use of truss rods and consequent need of adjustment.

Tenth. On account of the sweating and rusting of iron and steel, wood is preferable to iron or steel for flooring, siding and lining of merchandise and stock cars. Much has been said and written on the subject of corrosion of iron and steel brake beams, bolts, pipes, rails, etc., from the action of sulphuric acid leachings from coal cars and salt-water drippings from refrigerator cars and manure drippings from stock cars.

There is no doubt that there is serious corrosion from these and other causes under certain conditions, but evidence exists that steel framing under tenders and iron work under coal cars in constant service, and steel framing of cars exposed to very damp and destructive climatic influences for many years, have not suffered materially from these causes. Doubtless preservative paints can be found that if properly used when the steel frames are first built and with occasional repainting will sufficiently protect the steel from corrosion, but as this is a very important subject your committee would recommend that it be made a special subject for committee investigation by a series of tests ranging over nine or ten months' time.

There is an economical side to this question which your committee desire to call attention to before closing their report, namely, how much additional weight and how much additional first cost dare be put on a car without ultimate loss.

First. As regards the question of increased light weight of freight cars of given capacities having steel underframes, your committee feels that they need only state that it is proven to be quite practicable to build cars with steel frames of greater strength and capacity with less light weight than when wooden or composite underframing is used, and that with more experience in the right methods of construction and a proper appreciation of the capabilities and best uses of steel, the proportion of carrying capacity to light weight can be still further increased for large capacity cars without danger of increasing the subsequent running repair account.

Second. With regard to the question of probable increased first cost of freight cars having steel underframing, the burning question here is, "Will it pay?" There are so many factors governed by local conditions which must enter into the calculation that each company must perform figure this out for its own set of conditions.

One factor, namely, the repair account should, however, here receive passing notice. From the best information obtainable your committee believe that it is very nearly correct in stating that the charge for wheels, axles, springs, paint, chain, brake shoes, brasses, couplers and other parts that will wear out and fail as much under the most perfect steel-framed car as under the poorest design of wooden-framed car in the same service will constitute about 50%

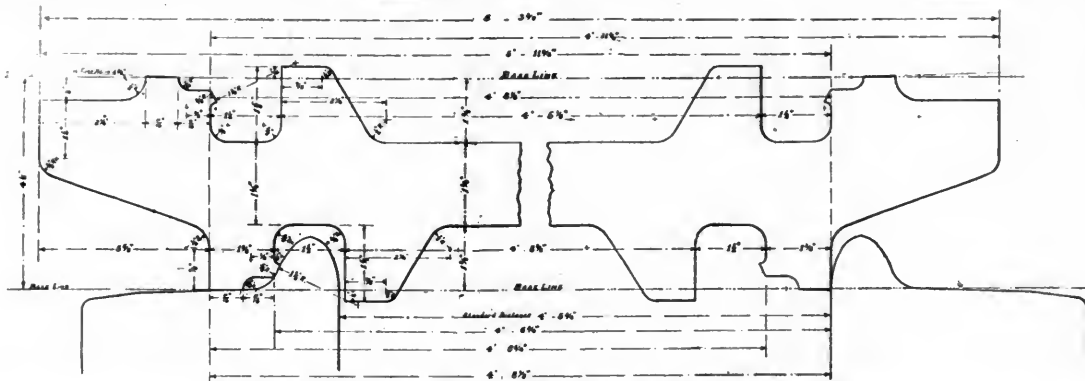


Fig. 1.—Standard Reference Gage for Mounting and Inspecting Wheels.

per cent. of the average total cost of freight-car repairs, exclusive of inspection, oiling and packing. Then the two question remain:

First. Of the remaining 49½ per cent. how much can probably be saved by the use of a perfect steel underframing which would require no repairs except painting during the life of the car?

Second. Will this saving, added to the increased freight earnings of the car and to the increased mileage earnings when away from home (due to a less number of days per annum spent on the repair track), pay the interest and depreciation on the extra first cost of the steel car?

Taking the figures given in "Poor's Manual," the freight earnings per revenue car for 1894 were about \$1.38 per day, and the average mileage earnings of cars away from home are only about 15 cents per day.

Where the freight-car repair work is being kept up currently, the number of cars on the repair tracks can be kept down to 4 per cent. of the total equipment; this means that each freight car would spend about fourteen and one-half days on the repair tracks each year. If we assume that only 40 per cent. of this could be avoided by the use of perfect steel framing, we can possibly save about six days on the repair tracks per annum.

This would mean, if the freights were available, increased freight earnings of \$8.28 per annum per car, or 90 cents additional mileage earned per annum per car away from home.

It is about right to assume, including private cars, that 30 per cent. of all freight cars are constantly away from home.

Taking one lot of 1,000 cars we can assume that as above the freight earnings could be increased..... \$8,280.00 per annum
The mileage earned from foreign roads increased..... 300.00

Estimated possible saving in repairs, say 20 per cent.
of \$72 per car per annum..... 14,400.00
\$22,980.00

As the steel framing when put up in lots by bridge builders ought not to increase the cost of cars more than \$75 per car at most, this figure of \$22,980 per thousand cars for savings and increased earnings would approximate 36 per cent. per annum on the extra capital invested, amply sufficient to cover the depreciation and interest charges under the conditions above assumed.

At the time of closing this report it is learned that the Illinois Steel Company is at work on designs for steel cars, drawings for which it is hoped will be received in time to present to the convention. It is also expected that a Norfolk & Southern steel flat, Norfolk & Western steel flat and steel framed hopper, Pennock steel car, Carnegie and Illinois Steel Company's cars will be completed and on exhibition at Saratoga for inspection by the members.

[The report is accompanied by drawings of the Norfolk & Southern steel flat car (illustrated by us in March, 1894), the steel bolster of the Northern Pacific (see our issue of March, 1896), the C. B. & Q. car with steel sills (in our issue of March, 1896), the Norfolk & Western steel flat and hopper cars of 20 tons capacity, a proposed design of steel frame for a 36-foot 30-ton car submitted by Messrs. Sanderson and Wentworth, the Pennock steel car, Trapp's 80,000-pound steel car, Player's steel frame and Carnegie Steel Company's hopper car of 100,000 pounds capacity. The latter cars weigh 39,000 pounds light. Some of these cars not already illustrated by us, and not found herewith, will be published later in a more complete manner than would be possible at present.—EDITOR.]

Mounting Wheels.

J. N. BARR, R. E. MARSHALL, J. C. BARBER, PULASKI LEEDS, J. H. McCONNELL, A. M. WAITT, THOS. SUTHERLAND.

The committee believes that the standard dimensions for wheel gages, as given in the Proceedings of 1895, are proper. In consideration of the check gage for mounting wheels, as shown in Plate 12, and the standard wheel gage, as shown in Plate 7 (M. C. B. Proceedings, 1895), it believes that these two gages should be combined, as shown in Fig. 1, and that the term "Standard Reference Gage for Mounting and Inspecting Wheels" should be applied to the combination.

It does not think that the gage in this form is suitable for practical work, either for mounting or inspecting wheels, but is more properly a reference gage; and it is for this reason it has suggested the name above. Attention is called to the fact that a slight change is made in the gage by enlarging the surface which comes in contact with the outside of flanges.

For the purpose of practical use in inspecting mounted wheels, both in shops and on the road, your committee presents a design, shown in Fig. 2, to be entitled "Standard Check Gauge." The only dimensions in this gage which differ from that shown in Fig. 1 is the distance between gage points, which is 4 feet 8½ inches instead of 4 feet 8¾ inches; but as this dimension is not used in inspecting, the discrepancy is immaterial.

The following instructions for using the proposed check gage explains all points in connection therewith:

INSTRUCTIONS FOR USING STANDARD CHECK GAGE.

In using the proposed check gage, if the projections *A* and *B* do not enter between the flanges, and the projections *C* and *D* rest upon the treads of wheels, the wheels should be rejected.

If the projection *A* is pressed against inside of the corresponding flange, the projection *C* resting on the tread, and the projection *B* does not allow the projection *D* to rest on its corresponding tread, the wheels should be rejected.

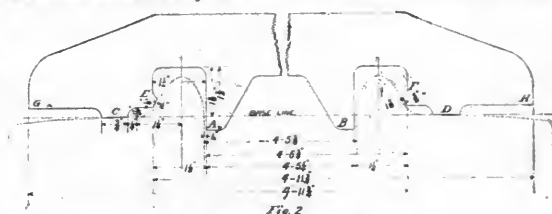


Fig. 2.—Standard Check Gage.

Also, if *F* and *D* are pressed against the flange tread of wheel, and *C* does not come in contact with tread on account of *E*, the wheel should be rejected.

If *E* and *C* are pressed against flange and tread, and *H* extends beyond the outside of tread, the wheel should be rejected.

The same if *F* and *D* are pressed against flange and tread, and *G* extends beyond outside of tread.

Your committee presents, in Fig. 3, a light and simple form of gage for mounting wheels symmetrically on the axle. This gage has been in practical use for over a year and gives very satisfactory results. For those desiring to mount new wheels from the outside of the flange, a suitable modification can readily be made. In the case of second-hand wheels, however, it is the opinion of your committee that the best practical results will be obtained by mounting from the inside of flange, and it is also the opinion of some of the members of your committee that the above remarks are equally true in the case of new wheels.

The committee believes that the best results will be obtained by the constant use of the proposed Standard Check Gage, at three or more points on the periphery of the wheels after mounting, as a positive guarantee of conformity to standards.

Your committee desires to urge upon all members of the Association the use of the standard maximum and minimum flange gages as a test requirement for all new wheels purchased before fitting them to axles.

In conclusion, it would summarize its recommendation as follows:

RECOMMENDATIONS.

First. That a standard reference gage for mounting wheels, covering the standard dimensions, shown in Fig. 1, be adopted, which shall combine the present check gage for mounting wheels, shown in Plate 12 of 1895 Proceedings, and the standard wheel gage, shown in Plate 7 of same year, the new combined gage, to supersede the other two.

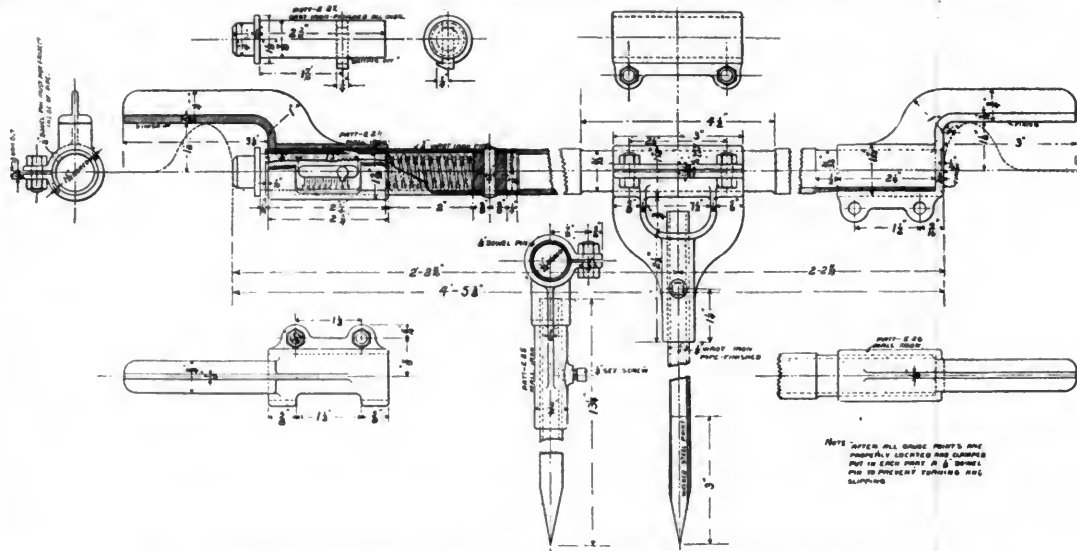


Fig. 3.—Cage Recommended for Use in Mounting Wheels Equidistant from Centers of Axles.

Second. That a standard check gage be adopted as shown in Fig. 2.

Third. That a gage for determining the center of the axle between centers of journals be used.

Fourth. That a gage for locating wheels equidistant from the center of axles, as shown in Fig. 3, be adopted as recommended practice.

Fifth. That all axles be carefully centered between centers of journals prior to mounting.

Sixth. That wheels with flanges worn to a thickness of $1\frac{1}{2}$ inches or less should not be remounted.

Seventh. That, as far as possible, the thickness of flanges of wheels fitted on the same axle should be equal, and should never vary more than $\frac{1}{8}$ inch.

Eighth. That in mounting second-hand wheels, they be mounted to the standard distance between inside of flanges.

Freight-Car Doors and Attachments.

F. H. SOULE, J. J. CASEY, W. J. ROBERTSON, B. E. THOMSON, THOS. FILDES, CHARLES WAUGHOP, A. J. CROMWELL, MORRIS ROBERTS, Committee.

Your committee, appointed to report on the latest improvements and best practice in freight-car doors and attachments, respectfully submits the following data derived from the replies to circular of inquiry, indicating the kind of door standard to the several roads, and embodying therein the latest improvements in door attachments:

1. Total number of roads replying to circular 23, representing 274,434 cars.
2. Standard door on 13 roads, representing 123,810 cars, "Dunham."
3. Standard door on 3 roads, representing 40,614 cars, "Wagner."
4. Standard door on 3 roads, representing 7,851 cars, "Moore."
5. Standard door on 1 road, representing 17,460 cars, "Safety."
6. Standard door on 1 road, representing 22,438 cars, "Eubank."
7. Standard door on 1 road, representing 213 cars, "Lone Star."
8. Standard door on 1 road, representing 6,553 cars, "Kanaky."
9. Standard door on 2 roads, representing 27,353 cars, "Old style sliding on bottom rail."
10. Standard door on 3 roads, representing 33,131 cars, "Old style top hanger, sliding on flat iron."
11. Special safety brackets at bottom of door to prevent opening of door without breaking of seal are standard on six roads, representing 105,297 cars.
12. Special designs for door fastenings.
13. All but three of the twenty-eight roads employ the "batten" form of construction.

Your committee does not understand that its appointment contemplates a report on the merits of any particular device, or that the detail for recommended practice or standard door should be submitted. As covering, however, in a general way, the special features desirable in connection with an ideal freight-car door for box, stock and other classes of freight-car equipment, your committee would respectfully recommend that:

First. The door should be so constructed as not to be liable to bind or give trouble in working on account of swelling or warping slightly.

Second. The door should be hung at the top with no rail at the bottom which can be bent, and, from being bent, interfere with the free running of the door.

Third. The door should be hung so as to move readily by a small

amount of force when applied either at the bottom, middle or at the top.

Fourth. The door should not move easily enough to roll back and forth by the alternate forward and backward jerks that the car gives in a freight train.

Fifth. The door should be so arranged as to be weather and cinder proof at the top, bottom and both sides when closed.

Sixth. The door should be so constructed that when it is locked and sealed, it would be impossible, without breaking and mutilating the door, to pry open the back end or bottom of the door, so as to permit entrance of the hand or hook to pull out portions of the lading.

Seventh. The door should be so constructed that if the lading presses against it and bulges it out from the inside when it is closed, it cannot be pressed away from the car so as to swing out and strike passing trains or other objects at the side of the tracks.

Eighth. The door should be so constructed as to make it absolutely proof against unhooking; excepting where the stop, against which it rests when open, is removed and the door taken off in the regular way.

Ninth. The door should be so constructed as to prevent it swinging out when in its closed position, even though all of the bottom brackets are removed.

Tenth. The door should be so constructed as to be proof against swinging out when in its closed position, in case one of the hangers should be broken or lost off.

Eleventh. The door should have such a style of locking arrangement that it cannot be removed or tampered with from the outside, without at once making the fact known to the seal record taker as soon as he sees the fastening.

The above conditions should be considered as applying to end doors as well as side doors, with special reference to locking arrangements, which should have the same or equal provisions for sealing. In this connection, and for such action as the Association may be pleased to take, a communication from Mr. John T. Denniston, President Freight Claim Association, is submitted, in which he asks whether this Association "could adopt a resolution requesting that all roads owning cars with end doors would make provision thereon that they could be sealed on the outside, so that a proper record could be obtained to enable the freight-claim agents in handling claims to properly locate the liability therefor."

In conclusion, the committee would refer to the danger to life and property incurred in the handling of private line cars equipped with blinged doors swinging outward. In the opinion of the committee such doors are much more dangerous to passing trains than any other type of freight-car door extant. Such doors are inherently dangerous, from the fact that if unlatched they will gravitate to open position on the slightest oscillation of the car. Again, in many cases, they swell to such an extent as to prevent them from closing properly. The fastenings are also continually getting out of order.

The committee is in hopes that the Association may take some action that will prompt the private line people to the adoption of some safer form of door.

Handholds and Height of Drawbars.

This report is simply a more complete presentation of the practices recommended by the committee as desirable and conforming to law, which was outlined in a statement furnished by them and issued by the association in August last. That statement, together with the diagrams accompanying it, can be found in our issue of September, 1895.—[EDITOR.]

AMERICAN ENGINEER CAR BUILDER AND RAILROAD JOURNAL.

AUGUST, 1896.

THE ALTOONA SHOPS OF THE PENNSYLVANIA RAILROAD.

II.

(Continued from Page 93.)

The proceedings of the two conventions held in Saratoga in June occupied so much room in the July number of the AMERICAN ENGINEER as to crowd out the second article on the Altoona Shops. As it was thought that this could be written better on the ground than from notes made during a previous visit, a second journey was planned, partly to escape the heat of New York and to enjoy a sojourn among the hills, where Altoona is located, and also to refresh recollections of the subjects noted in a previous visit. Having a decided aversion to sleeping cars when the thermometer is in the neighborhood of the nineties, the train which leaves New York at 2 P. M. was chosen for the journey. At that hour the thermometer was balancing in the vicinity of 90 degrees or above, and therefore an ordinary coach was taken at Jersey City in preference to a drawing-room car, for the reason that the latter are apt to be insufferably hot in warm weather when they are run in vestibuled trains. In coaches windows are kept open, and a circulation of air is thus obtained, whereas in drawing-room cars there seems to be some reason why the windows must be screened if they are opened, and ordinarily there are only a few screens for the many windows. The coach selected was immediately behind the dining car in the same train. A brisk westerly breeze was blowing into the great trainshed in Jersey City, with the result that the combined odors from the kitchen of the dining-car were wafted into that behind it. This is often, and was then, very disagreeable in vestibuled trains, but is especially so on a hot day. After theorizing about bad smells a good deal the conclusion reached is that there are a great many railroad men who are color-blind in their noses. As evidence of this it may be said in designing drawing-room and sleeping cars, instead of putting the door of the smoking-room toward the end of the car, they are often placed so that they face toward the middle of it, or possibly toward its side, so that when a current of air enters the front end door, as it will when the train is in motion, it drives the smoke from the apartment where bad cigars are consumed and worse stories are told, into the middle of the car. In the much vaunted but viciously ventilated vestibuled trains a carefully constructed conduit is provided which carries the bad smells and the foul air from one end of the train to the other, so that the occupants of the rear cars must breathe a sort of atmospheric hash consisting of the odors of tobacco, multitudinous smells from the kitchen and scullery of the dining-cars, the exhalations from the lungs and bodies of washed and unwashed travellers, and when the latter take their boots off the air literally becomes *fetid*. This conduit is constructed at great expense, it adds largely to the weight of cars, is an obstruction in getting in and out of them, makes the train harder to pull, and forms a sort of trap for collecting microbes and the seeds of disease and death. There are trains of this kind which also run out of the Pennsylvania station in Jersey City, the cars of which are marked "F. F. V. Limited," which connect with some of the Virginia railroads. A traveller, who took one of these trains, and found the ventilation very bad, interpreted this lettering to mean "fright-fully ventilated." Our criticism is that vestibules make trains very warm in summer, and that by preventing the escape of bad air, and the entrance of that which is pure between the cars, they make good ventilation more difficult than it is without them; that ingress and egress to and from the cars is more inconvenient than it is when vestibules are not used;

they are expensive and heavy, and the advantages do not compensate for these disadvantages. Simple gates in the platforms would make the passage from one car to another secure, which is all that seems to be demanded.

It is not often that any good reason can be found for criticising the Pennsylvania Railroad cars. There is though, it is thought, good ground for finding a little fault with the fastenings of the windows and blinds in some of their coaches. In the first place there is no provision made for holding the window sash or the blind in any position in which it may be desirable to have it. There is but one stop so that the window must be wide open or closed entirely. Often it is desirable to have the sash raised only a few inches, and the blind lowered part way to keep the sun out, but not to obscure entirely the view. The fault with the fastenings is that some of them will not fasten, and one blind could not be moved at all. Surely the mechanical genius of the Pennsylvania Railroad is able to devise something more effective than what they are now using. Of course these are hard times and what with the threats of free silver, bad business and general distrust we probably will be obliged to be content with defective sash locks, at least for the present.

After emerging from Jersey City the first greeting was a prolonged whiff of bad odors from the manure piles on the meadows near the Pennsylvania Railroad shops. One cannot help but drop a word of sympathy for the masters in charge, and the men employed in these shops who must endure the stench which exhales perpetually from this locality. Happily for mankind it becomes accustomed to all sorts of disagreeable things, odors among others, and our friend the editor of the *Master Mechanic* intimates that he enjoys vile perfumes such as tobacco, onions and skunks, and seems to think that those who do are in some sense superior to those who do not. The train swung through Newark and then to the real country, which God made, and we soon glided to the leeward of a hay-field, with real hay-cocks, and the aroma of new-mown hay. Thanks to Colonel Waring, the odor of the streets of New York is not as bad as it was in the days when Tammany held sway, but even now the metropolitan atmosphere in July is not suggestive of perfume, so that the smell of the hay-field, as it was swept into the windows of the car, seemed like incense, and suggested the experience of long ago when hay-making was one of the occupations of the writer and he was free from the drudgery of squeezing ideas out between the ribs of a pen. How fresh and grateful the country looks to one who sees daily little excepting bricks and mortar! In some of the fields the grain was freshly cut, the corn just ready to burst open with its crown of glory, the grass and foliage in its full midsummer luxuriance, and every tree seemed to be clad in coronation robes in honor of us poor mortals who come to look upon them. Verily those of us whose daily lives are spent apart from these glories, of which nature is so lavish, lose much that makes life worth living.

The 2 P. M. train is a fast one, so we were whirled through Elizabeth, with its new elevated railroad above, and clear of the New Jersey Central crossing where for so many years the only guardian angel who stood between death and thousands of people who traveled on the two roads was a faithful Irishman with a red flag by day and a red light by night. Happily the danger of this grade crossing is now non-existent, and the traveler who knew of it is no longer obliged to hold his breath—as some of us did—every time we reached this dangerous intersection of two roads. Rahway came and vanished. New Brunswick, with the quiet college shades in sight of the road, as we whirled past the old superannuated station: Princeton Junction, with the trees and apices and towers of the seat of learning in view, in the hazy distance, all robed in the panoply of midsummer. To a person who has traveled for nearly half a century by rail between New York and Philadelphia, it is a little unexpected to pass through Trenton without being delayed, and without stopping or being greeted with the cry of peripatetic train boys of "fried oysters and ham sandwiches." The train on this occasion did not stop. Trenton is the seat of Jersey politics and potteries. The train crossed the Delaware River quickly on the strong iron bridge, which recalled the old creaky wooden structure which years ago occupied this

place and had to be crossed at reduced speed, and also brought to mind that it was not very far from the site of the bridge that Washington made that celebrated crossing of the Delaware on a Christmas eve, the sequel to which was of such momentous consequence to all of us.

On the Pennsylvania side of the Delaware the canal and slow-moving boats was suggestive of the past, and a number of bicycles and riders on the tow-path were indicative of the present. The contemplative canal-boat and the ruminant mules made a strong contrast with the alertness of the riders as they appeared in the shaded path which would have made a good subject for a picture representing the past and the present.

In Pennsylvania the well-cultivated fields were soon in view; there were more hay and grain fields, luxuriant corn, market gardens, green trees—beauty, fragrance and delight. The outlying suburbs of Philadelphia, which extend almost all the way to Trenton, with their shops and factories, looked warm and uncomfortable in the July temperature; but the air of comfort of many of the residences is unmistakable. The outlying portions of Fairmount Park were soon reached with its pathetic bronze statue of the wounded lioness, below the railroad the Zoological Gardens, the Art Gallery—a reminder of the Centennial Exhibition—which it seems impossible could have been held twenty years ago, and then a brief stop in the Philadelphia depot, which was hot and stifling, and after the seats were reversed the train was again headed westward.

A glimpse of the well-equipped repair shops of the Pennsylvania road, a rather smoky and dusty ride through the long yard, where there is an ascending grade, extending for some miles beyond, and we come to the matchless suburbs of Philadelphia, where her well-to-do people have made their homes.

A touch of tropical luxuriance seems to be apparent here, if we compare the foliage and the landscape with that east of the Delaware River. The ground west of Philadelphia is beautifully rolling, with groves of magnificent trees—oaks, chestnut and walnut. Some kinds appear here, such as the catalpa, Lombardy poplar, tulip-tree, sassafras, etc., which are not common in New Jersey. Truly it is a goodly land, and those old companions of William Penn acted wisely when they placated the Indians and took up their residence here. The wealth of Philadelphia has been lavished on this region. For a distance of 20 miles or more from the city there is a continuation of beautiful houses with ornamental grounds which nature, art and a protective tariff have combined to beautify. Many of the officers of this great road live in these places, and every facility for getting to and from their homes is given to the residents. Beautiful and convenient stations are located all along this portion of the line, and if the highest achievement of man, as it is said to be, is the creation of beautiful and happy homes, the residents here have certainly accomplished part of that end.

On the date of the journey which is here described the country was at its best. Recent rains had developed the foliage of the trees, the grass and the crops to their full perfection, and the heat of summer had not yet parched or withered any of them excepting the new mown hay. To a tired journalist baked and parched like a ball of pop-corn, and wearied by a metropolitan struggle for existence, the walks, verandas, nooks and shady places and well-made roads looked exceedingly attractive. What capacity for work such daily refreshment must give, what contentment and felicity must come if the household in such houses accords with their external appearance.

After the top of the long grade was reached the shower of cinders was less copious and exasperating. The magnificent view of Chester Valley was then revealed from a high ridge, which had been gradually ascended from Philadelphia. It would require the descriptive powers of Sir Walter Scott or Ruskin to do it justice. Here the suburban residences of city people are no longer seen and the homes of the true rural residents of Pennsylvania are indigenous. The land seems to exude fertility and fatness, and prosperity and comfort are apparent everywhere. In one of the fields a reaping machine was sweeping away the golden grain, a wagon with a typical team of Pennsylvania horses and

attendants, fat as the horses, in a grayish afternoon sunshine, the distant hills, hazy and soft in their outline by reason of a light veil of cloud which hung over it all made a beautiful scene. But the accusation of an attempt at fine writing will hold if this vein is continued, and as this article is intended to be descriptive of railroads, and not beautiful scenery or Pennsylvania farms it must be enough to say that the train glided on and on continuously, with only a slow up at a junction, from Philadelphia to Harrisburgh, through the surpassingly fertile and well-cultivated farms of Chester and Lancaster Counties, than which there is perhaps no richer farming land in the world. A brief stop in Harrisburgh after nightfall and the train again sped its way westward. A comfortable dinner in the dining car followed, but observation of the landscape was shut off by the darkness. Dining might be called an exercise of introspection, and to that an hour was devoted satisfactorily. About as much more time elapsed and the electric lights about the Juniata shops came in sight, and we were soon comfortably housed and roomed at the Logan House. Nothing which would interest our readers elapsed between then and the next morning, excepting that appointments were made to visit the shops and plans were formed for seeing and hearing whatever could be learned and observed that would be likely to interest the reader and the writer.

CLASS L ENGINES.

Our first article on the Altoona shops contained a view made from a photograph of one of the recently built Class L engines, with a view taken at the same time, and on the same plate of a class G engine, built in 1878, which showed in a very striking way the difference in size and appearance of the two engines. It was then promised that a fuller description of the most recent of these would be given. Through the courtesy of the able head of the department of mechanical engineering at Altoona we are able to give the a diagrammatic view on page 168 of one of these engines, of which some thirty or more have been built, and which are giving excellent service, and we are also indebted to the same source for the following data concerning them:

Their cylinders, as will be seen from the diagram, are 18½ by 26 inches; the driving wheels are 80 inches in diameter; the grates 10 feet long, and, as the firebox is on top of the frames, the width inside is about 42½ inches; the barrel of the boiler is smallest next to the smokebox, where it is 60 inches diameter, from which it tapers backward to a point about midway between the smokebox and firebox, where the tapered portion unites with a cylindrical ring or plate 68 inches diameter. The location of the dome, etc., can be understood more easily from the diagram than it could be from a description.

The fire-box is of the Belpaire type, in the construction of which some important improvements have been made. The crown-sheet is flat and horizontal both longitudinally and transversely. In order to allow of the upward expansion of the crown staybolts at the front end the two front rows and some of the ack stay bolts are fastened to the top plate, as shown in the sectional view Fig. 1 herewith, from which it will be seen that a brass thimble is screwed into the roof plate from the outside and the staybolt passes up through this without being screwed into it. A nut screwed on the top end of the bolt rests on a spherical washer, which has a bearing to correspond on the top of the thimble. A cap which covers the end of the bolt and its nut is then screwed in an external thread, on the thimble and serves to make this fastening steam tight. The illustration shows that the bolts are free to move upward, when the firebox is first expanded by the heat, and they are thus relieved of undue strains from this cause. When the shell becomes heated it expands and thus brings the washers to a bearing on the thimble. The ends of the bolts are riveted over the nuts, so as to prevent them from unscrewing. The lower ends of the crownstays are screwed into the crown-sheet, but have button-shaped heads below the sheet, with rounded fillets between the heads and the threads on the bolt. Square heads are forged on the lower ends of the bolts to screw them in, but these are cut off after

the bolts are in their position. The other crown bolts have similar fastenings in the crownsheet, but are screwed into the roof-plate and have a cap nut on the outside. The stay-bolts on the sides of the firebox are located as nearly horizontal as was practicable to permit the inside and outside plates to expand and contract as freely as possible without staining the bolts. The strains to which such bolts are subjected when they stand at a considerable angle to a horizontal line has been repeatedly pointed out, but notwithstanding that fact, the vicious

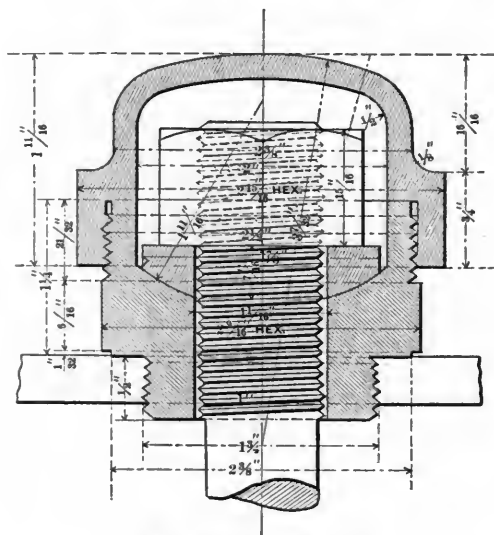


Fig. 1.—Expansion Staybolt.

practice of so arranging staybolts is still continued in many cases. The transverse rods over the crown sheet, which are so essential in the Belpaire boiler, are screwed into the plates and have an ordinary nut on the inside and a cap nut outside.

The water space on the sides and ends of the firebox is four inches wide, but the outside shell at the front end of the firebox is swelled out to the diameter of the largest ring of the barrel of the boiler. The square portion of the outside shell above the crown-sheet is somewhat narrower than the largest diameter of the shell so as to give as much room between it and the cab as possible. What may be called the swollen protuberance of the side sheets, back of the tubesheets, is gradually narrowed or "runs off to nothing" at the back end of the firebox. The object of this lateral extension of the side-plates, back of the tubesheet, is to give a convenient connection with the barrel of the boiler, but chiefly to give more water space between it and the firebox at this point.

The mud ring is double riveted all around. The radii of its inside corners are three inches. This permits the use of a number of rivets in each corner extending all the way through the metal of the ring. The outside contour of the angles of the mud ring are described from the same center as the inside corners are. The through rivets must therefore be radial to the inside and outside curves, and their outside ends are necessarily further apart than the inside ones are. Patch bolts are therefore screwed into the ring and pass through the external plates between the through rivets. The inside end plates have flanges to conform to the corner of the mud ring. The corners of the plates are reduced in radius as they rise above the mud ring and the flanges are made to correspond thereto.

The diagonal braces which are used to strengthen the ends of the firebox shell are attached to the flanges of trough or channel shaped plates riveted to the ends of the external shell. The same sort of attachment is used on the roof for thin braces. They have

the advantage not only of providing a good fastening for the braces, but of stiffening the plates to which they are riveted.

The front plate of the shell of a Belpaire firebox is difficult to flange, and has been regarded as a serious objection to the use of this type of boiler. In these engines, instead of making it of one piece it is made in two. The lower part is made in one piece, and extends up on the sides to within about six or eight inches of the center line of the boiler. The top portion is also made in a separate piece and extends down on the sides to within about the same distance of the center line. The cylindrical plate which forms the back ring of the barrel of the boiler is then cut so as to connect these two sections of the end and to the side plates of the shell.

The horizontal seams are all made with butt-joints quadruple riveted. The outside covering plates are 6 inches wide and the inside ones 12 inches by $\frac{1}{2}$ inch thick.

The smoke-box extension is made of a separate plate from the main part of the box. The latter has a wrought iron ring at the front end to which the extension is bolted. This is done so that it can be removed, which is often desirable when work must be done in the smokebox.

The inside arrangements of the smokebox were designed by Mr. Wallace, of this road, and of this we expect to publish an engraving before long.

Special attention has been given to facilities for washing out these boilers. With this in view besides the ordinary wash-out holes in lower portion of the firebox, three holes, with caps bolted over them are placed in the under side of the barrel conveniently located in its length. The front and back holes are 3 in. in diameter, and the middle one 6 in. Two three-inch holes are also placed on top of the barrel, back of the front tubesheet, and two in the angles on each side of the top of the firebox shell, one pair being near the front on one side and the other pair near the back on the other side. Observation has taught in Altoona, as it probably has elsewhere, that an important element in keeping boilers clean is to have sufficient force to the stream of water which is used in washing out the boilers. Special attention is now given to this, and better facilities are being provided to furnish a water supply of adequate pressure for this purpose.

The grates used in the class L engines are of the finger-bar shaking type. The bars or shafts extend transversely across the firebox, the fingers being 10 inches long measured from the end of one to the end of that opposite to it. The bars, and the spaces between them, are $\frac{1}{2}$ inch wide. At the front end of the firebox there are two dead plates which occupy 33 inches measured in the direction of its length, and back of these is a perforated drop plate 14 inches wide which can be turned so as to dump the fire into the ashpan. The grate-bars are carried on bearing bars of the usual form, bolted by lugs to the bottom of the mud ring. Special pains have been taken, of late, by the authorities in Altoona, to close up all openings around the sides of the firebox so as to exclude cold air from entering at such places. The object of this is twofold, one to keep the cold air away from the fire-box plates, and next to keep the fire away from them, as contact with the cold plates always has the effect of checking combustion. In the class of engines which is here described the bearing bars stand away from the sides of the firebox. In order to close the crevices which are thus left, cast-iron blocks are made which fit in between the bars and the plates, and with a sort of flange or head which laps over the top of the bar. These blocks are simply dropped loosely into the spaces referred to, and the flanges or heads close the openings. In some other classes of engines inclined plates are fastened to the mud-ring and bear against the sides of the firebox, and have joints formed by grooves in the plates filled with asbestos. This makes them almost air-tight.

The check valves are of a pattern designed by Mr. William Wright, chief draftsman, and are inside of the boiler. The valve itself is of a simple conical mushroom pattern, attached to a seat which is removable from the outside. Any injury to the feed pipes outside would not disturb the valve. The horrible accident, which occurred at Pittsburgh a good many years ago, when a whole car full of passengers were scalded, many of them fatally, by the

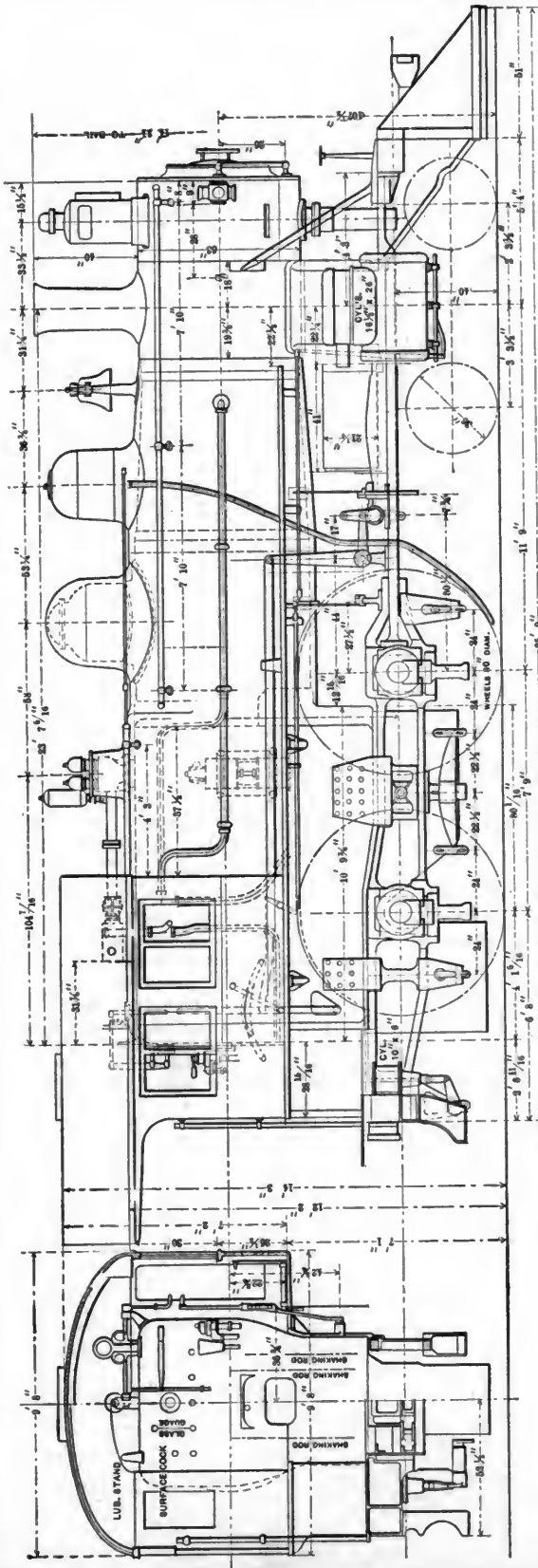


Fig. 2.—Outline Diagram of Fast Passenger Engines, Class L-1—Pennsylvania Railroad.

water which escaped from the check valve of an engine, which ran into the rear end of a standing train, has led to the general adoption of inside checks on the Pennsylvania road. The example should be followed by other companies. Another feature, which has been adopted for greater security against such accidents, is cast-iron brackets for running boards. These are made very strong where they are bolted to the boiler, but the projecting part is made with only strength enough to support the loads which they must carry. A comparatively slight blow will break off such a bracket and leave the attachments to the boiler intact, whereas, if a heavy wrought-iron bracket is used, it is apt in a collision to pull out the bolts by which it is fastened to the boiler, and allow the steam or hot water to escape.

The long runs which are now required of passenger engines make it necessary to give especial attention to the oiling arrangements. Of course, ample bearing surfaces are a great help to lubrication. The links in the engines here described are made three inches wide, and they are so made as to provide suitable attachments for oil cups for oiling the pins, by which the rods are attached. Separate oil cups are also attached to the link hangers. The blocks instead of being made with the flanges on one side solid with the block, and a loose plate on the other, are both loose so that when they are worn they can be reversed from one side to the other. They are fastened with two bolts and two studs.

The crossheads and guides of these engines are of a new design by Mr. Vogt, Mechanical Engineer, which we hope to illustrate in a future number.

The piston-rods are fastened to the crossheads with a somewhat obtuse taper and with a bearing against the end of the rod. A rather "cute" expedient is adopted in making the slots in the piston-rods and crossheads. The key is of course tapered, and its back edge must bear against the rod to force it into the socket, and its front edge must rest against the crosshead. The slot in the rod is therefore cut square with the outside of the tapered portion of the rod, and consequently conforms with the tapered form of the key. The form of the back edge of the key slot in the rod does not matter because the key don't touch it. The slot in the crosshead is made square with the axis of the rod, and coincides with the back edge of the key, which stands vertical. The form of the front edge of the key seat in the crosshead is of no consequence because the key don't bear against it. It is therefore not necessary to make either of the slots tapered, which saves considerable work.

The rockers also have some peculiarities. They are made of wrought iron, the shafts being 4 inches in diameter. Between the two arms are two collars which divide the shaft into three parts, the two outer ones alone being used as bearings, which work in bronze bushings made in two parts and held in the rocker-boxes. The collars provide additional end-bearings to resist the wear of the rockers in that direction.

To avoid the awkwardness of making and of handling the lifting shafts when the arms are all forged on, the vertical arm is made separate from the shaft. A circular flange is made on the end of the shaft and is turned up with it. The arm is then bolted to it with six bolts.

The main and coupling rods are fluted, the "big-end," as our English friends call the main stub-end, is of the forked pattern, and the coupling rods have solid ends and bushings.

One of the appliances which is used on these and other passenger engines on this road is the Moran flexible steam joint between the engine and tender, for conducting steam for heating the cars, from the locomotive boiler to the train. This is shown in Fig. 3, which is a view taken from near the ground looking upward from the engine toward the tender. The device consists of a system of ball joints and pipes which form a flexible steam-tight connection, to take the place of rubber hose. Fig. 4 represents an external view of one of these ball joints, and Fig. 5 is a sectional view. The principal feature in this joint, and which has made it successful when other joints have failed, is that it is made with a certain amount of play or looseness, and it becomes steam-tight by the internal pressure bringing the spherical surfaces in contact with each other, and holding them thus, so long as there is any pressure in the pipes. When there is not, there of course is no occasion for the joint being tight. A relief valve

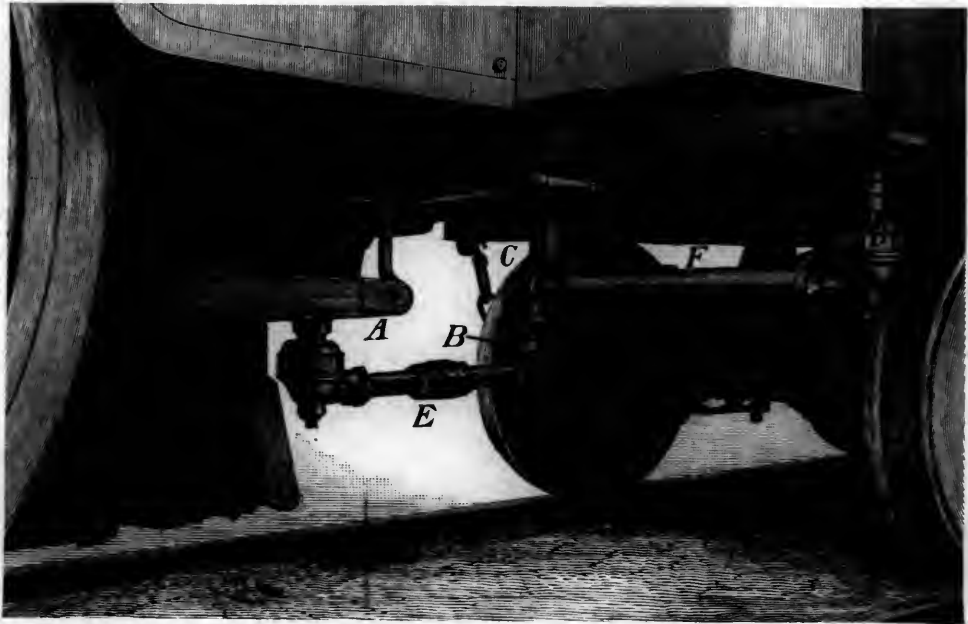


Fig. 3.—Moran Flexible Steam Joint Between Engines and Tenders on Pennsylvanin Railroad.

is shown in the lower part of Fig. 5, which consists of a ball which is raised by a spiral spring below it. When there is pressure in the pipes this ball is pressed down and on the seat below it is then tight, but when the pressure is released the spring raises the ball and allows any condensed water in the pipes to escape. Referring to Fig. 3, *A* is a ball joint connected to a fixed pipe in the engine. *B* is a similar movable joint, which is suspended by links *C* from a trolley above, which has a certain amount of longitudinal movement to compensate for that between the engine and tender. *D* is a third ball joint attached to a fixed pipe on the tender, which extends backward and connects with the train behind it. *A* and *B* are connected together by a pipe *E*, and *B* and *D* by a pipe *F*. As the latter stands crosswise and as *B* can move longitudinally, and all the joints are flexible, it is obvious that this form of connection can adjust itself to any position that the engine and tender can assume on the track when coupled together. This system of connecting pipes has been made a standard on the Pennsylvania road, and, it is reported, is working very satisfactorily, after a test of several years' actual service.

The spherical portions are made of cast-iron and no difficulty is experienced in keeping them tight. The manufacturers are the Moran Flexible Steam Joint Company, of Louisville, Ky.

In designing the cylinders of these engines care was taken to keep the steam pipes separate from the exhaust pipes, so as to avoid the cooling effect of the latter on the live steam. Ample provision was also made for draining both the steam and exhaust pipes. A cock is connected with the operating mechanism of the cylinder cocks, so that before the latter are opened the steam pipe can be drained, and it is kept open as long as the cylinder cocks are.

The driving springs as shown by the diagrammatic view are underhung, the firebox being on top of the frames. Liberal sized steps are provided on both the engine and tender, with very conveniently located handholds on both. The arrangement of throttle lever is a little peculiar. As will be seen from the dia-

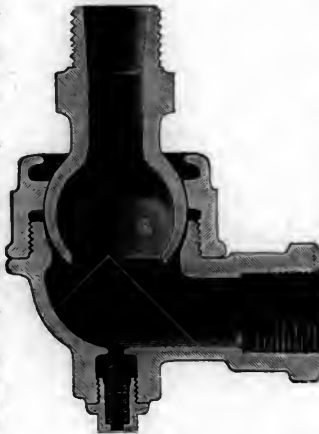


Fig. 5.



Fig. 4.

Views of Moran Flexible Steam Joint

grammatic view, there is the usual throttle lever back of the firebox. As the engineer occupies a position on the side, it is desirable to have the lever farther forward. A horizontal shaft, shown in the diagram, is therefore placed on the top of the firebox, which has a vertical arm located in the transverse center of the engine, and is connected with the throttle lever by a rod. On the outer end of the shaft there is a pendent lever, with a cranked handle or the engineer.

The appearance of these engines is very impressive. As shown in the diagram, the centers of the boilers are 107½ inches above the rails. They are of large diameter, so that the body of the machine is high and the Belpaire firebox adds to the massiveness of its appearance. The engines have been doing excellent service and reflect much credit on the designer. As mentioned in our first article, they weigh 134,500 pounds, and carry 185 pounds of steam pressure per square inch.

(To be continued.)

on a 10 per cent. incline, roughly, 30 horse power. For a speed throughout at the rate of 15½ miles per hour on a good level road, about 5 horse power is necessary; on a bad road, 9 horse power; on an incline of 1 in 20, 20 horse power; and for an incline of 10 per cent. rise, nearly 40 horse power.

If the weight of the vehicle when laden was, say, 1 ton; the horse power necessary for similar speeds would be two-fifths of the figures given above. This I mention, because 1 ton is approximately the weight of most petroleum motor driven carriages when laden.

If it now be desired to travel on the level and up hill at an unvarying speed of, say 12 miles per hour, such a carriage should carry an engine capable of giving from 2 horse power up to 12 horse power. Since the majority of the carriages in question are fitted with engines incapable of giving more than 4 horse power, the desired uniform speed of 12 miles per hour will, therefore, be reduced to one-third, viz., four miles per hour where a 10 per cent. incline is reached. This is what they realize in practice, and may be taken as a very good proof that the figures I quote are approximately correct.

The general analysis given above is instructive, for the reason that it teaches two important facts which are essential when a given average speed is required: (1) That no vehicle is of much service for heavy work unless an engine capable of giving out not less than 30-horse power is fitted; (2) that for light traffic the engine should give not less than 12-horse power for the maximum.

That both these conditions can be fulfilled with steam has been proved, but in the case of petroleum-driven motors I do not think that the result has yet been satisfactorily obtained. To increase the power of the latter form of engine threefold means in practice that its weight would be at least twice as great, and that more water would have to be carried for cooling the cylinder or cylinders, water in all probability being lighter than any form of cooling apparatus to do the equivalent duty. It is, therefore, clear that if the petroleum motor is to be heavier, the first conditions stand altered, and in consequence of the carriage being heavier, the speed will be reduced, or a still larger engine must be carried.

I therefore conclude, in the present state of our knowledge, that if the light petroleum-driven carriage is required to run at an average speed of 12 miles per hour on good and bad roads, where inclines exist up to a 10 per cent. rise, the carriage laden will probably weigh not less than 1½ tons and require a maximum of not less than 18 to 20 horse power.

The *Aluminum World* gives the following rules with regard to obtaining the best castings with aluminium bronze. An essential point is the special care to be taken not to overheat the metal, for if it be heated to too high a temperature, the aluminium will oxidize, the oxide which is thus formed making the entire casting "dirty"; the metal will also be spongy from the presence of large amounts of occluded gases. The scum, which floats on top of the melted bronze in the crucible, must be prevented from going into the body of the casting. The greatest trouble in making bronze casting, however, arises from the great shrinkage of the metal, a difficulty which is overcome if the casting have a large sinking head and "risers," it being necessary, however, in many cases to make the sinking head fully as large as the casting.

In the latter part of June the *Lucania*, of the Cunard line, and the American built *St. Paul*, of the American line, made remarkable western trips across the ocean. The *Lucania* averaged 21.37 knots per hour for the entire distance, 2,855 nautical miles, while the *St. Paul* averaged 20.58 knots for the distance covered by it, namely, 3,113 nautical miles. The best day's run of the former was 562 knots, and of the latter 540 knots. These speeds are enormous, being about 28 and 26 statute miles per hour respectively, maintained for 24 hours. The *Lucania* has about 30,000 horse power and the *St. Paul* nearly 22,000. Consequently, with about 40 per cent. more power, the British boat made only about 4 per cent. more speed. Of course the British boat is the larger, but there is not enough difference in tonnage to account for the difference in performance. The greater coal consumption of the Cunarder, amounting in all probability to at least 150 tons per day, and the greater cost of operation attendant on the larger boat, may have their effect in deterring other lines from attempting a speed of 22 knots, though the new North German Lloyd boats are to have a horse power of 28,000.

The Preservation, Maintenance and Probable Durability of Rolling Stock with Metal Underframes and Metal Upperframes.*

BY M. L. TOLMER, SUPERINTENDENT OF THE SHOPS OF THE EASTERN RAILROAD OF FRANCE AT MOHON (ARDENNES).

The substitution of iron sections for wood in the construction of cars date on the Eastern Railroad of France from the year 1861. From 1861 to 1866 about 1,840 cars, 4.8 metres (15 feet 9 inches) long over the bodies, and designed for the transportation of coal (known as series L) were built with the upperframes,† or frames of the box, of iron. By this innovation the weight of these cars was reduced to 4,300 kilograms (9,469 pounds), while the weight of similar cars of wood was 5,000 kilograms (11,000 pounds).

The endeavor to reduce the dead weight, the difficulty of procuring large and long timbers free from defects, the high price of such timbers and the progress in metallurgy which permitted the production of iron sections of exact dimensions all led to the employment of iron in the construction of rolling stock. It was with such ideas as these that there was built in 1865 the first cars having mixed underframes, that is, frames partly of iron and partly of wood, the sills which the pedestals were attached being of I or channel sections 250 millimetres (9.8 inches) high.

M. Boutard, Engineer of Rolling Stock on the Eastern Railroad, in 1868 designed a car of 10 tons capacity, provided with high sides (for the transportation of coal and coke) of which the underframes and upperframes were entirely of iron. This car, quite remarkable for that period, was made 5.5 metres (18 feet ½ inch) long over the body. It weighed empty only 5,320 kilograms (11,700 pounds), and combined lightness and strength to a greater degree than similar cars with wooden or mixed frames already in existence.

From the beginning of 1869, all the cars of the company have been built with the underframes of iron, and the uncovered freight cars having high sides (series L and H) have had the upperframes of iron also. With the inauguration of these designs the length of the car bodies have increased, until to day they have attained a length of 7 metres (22 feet 11½ inches) for cars in regular service, while this figure has been exceeded considerably in special cases.

Certain other companies, for various reasons, have gone much further in this direction, and have adopted types of cars in which the entire box or superstructure is of iron. The Eastern Railroad itself possesses 120 cars (series U and U¹) purchased from the Compagnie Léonville-Sedan, which conform to these types, the flooring alone being of wood.

The Eastern Railroad possessed on December 1, 1895, a total of 28,504 cars, as follows:

7,613 cars with underframes and bodies of wood.
1,880 cars with underframes of wood upperframes of iron.
3,249 cars with mixed underframes and upperframes of wood.
1,276 cars with mixed underframes and upperframes of iron.
14,860 cars with iron underframes and of which 3,761 also had iron upperframes.
120 cars with iron underframes and entire box of iron.

Without dwelling upon the great progress realized in construction by the employment of metal parts, we will at present discuss the life which it is reasonable to attribute to these cars, and estimate under several conditions varying with the time, the expense involved in their current repairs.

In the study of this question of great interest, which was entrusted to us by M. Salomon, Engineer in Chief of Material and Motive Power of the Eastern Railroad, at least in respect to the rolling stock of that company, we have taken apart and examined, piece by piece, a certain number of cars built in the earlier years. Each piece was weighed, after having the paint and rust removed from its surface by scraping and brushing. Moreover, the exact outlines of the various sections were determined where the wear or loss from rust had been great or was of special interest. The weights obtained have been compared with the weights of the same parts when new, to determine the proportion of metal lost. In making this comparison we have had at our service sections of the same dimensions found in the storehouse.

*Translated from the *Revue Generale des Chemins de Fer*.

†All the cars here considered are carried on four wheels and are of a type resembling the flat-bottomed gondola cars in this country. By upperframes is meant the frame or skeleton of the sides and ends which form the box.

†Of 4,793 passenger cars owned by the company, 1,183 have wooden underframes, 471 have mixed underframes, and 3,139 have underframes entirely of iron. Of 1,374 cars partly owned by the company, 280 have wooden underframes, and 1,094 have underframes entirely of iron.

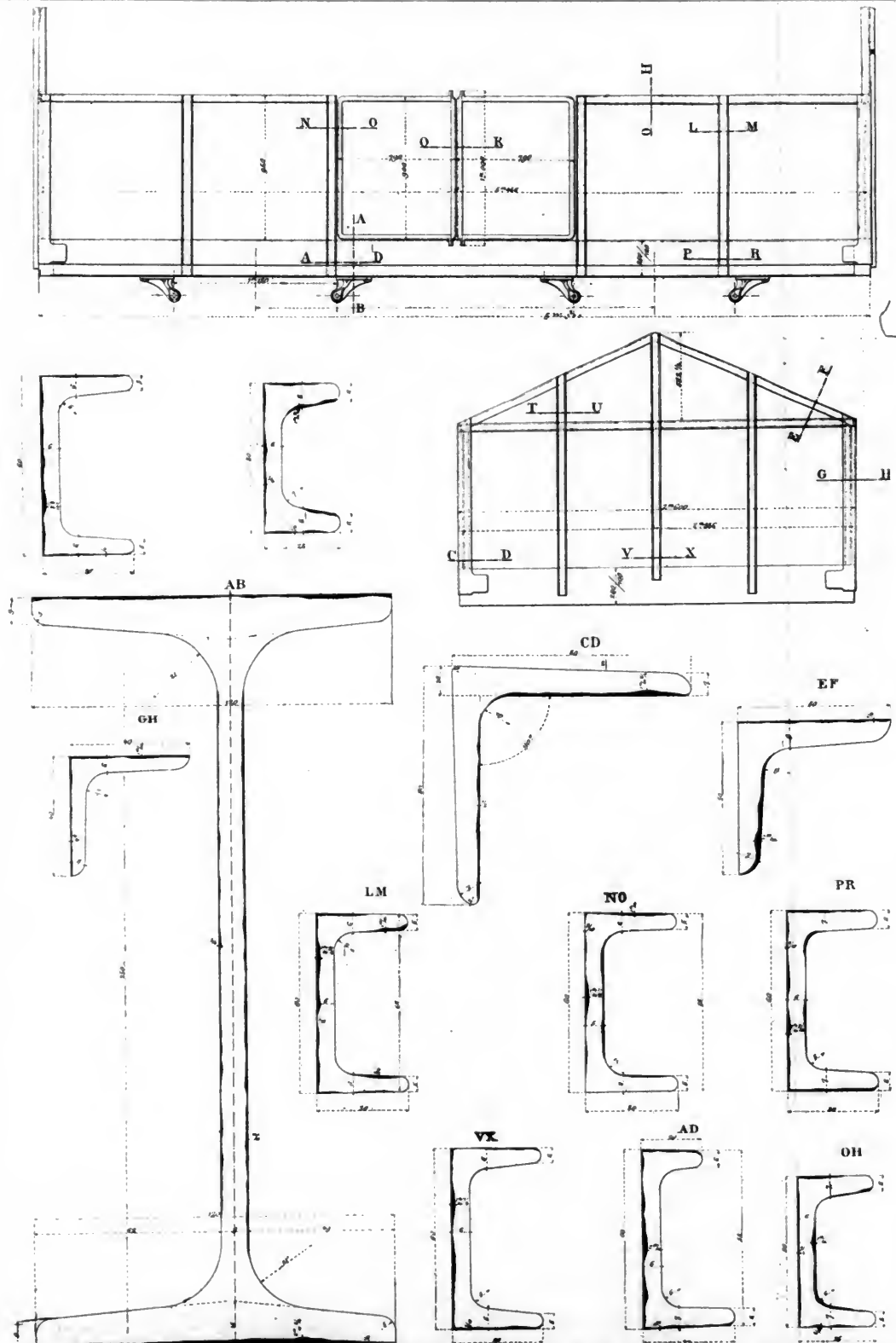


Fig. 2.—Side and End Elevations and Sections of Iron Members of Cars with Mixed Underframes and Iron Upper Frames Built by the Eastern Railroad in France in 1865.

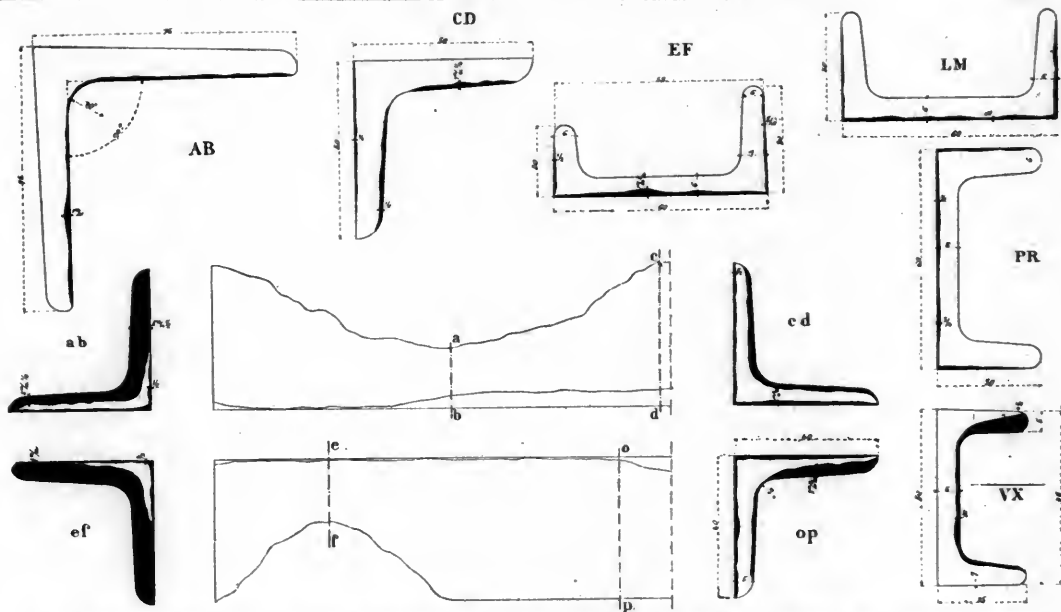


Fig. 1.—Sections Showing Corrosion of Steel Upperframes on Cars Built by the Eastern Railroad of France in 1861.

NOTE.—Ca a were somewhat similar to design shown in Fig. 2, but had wooden underframes. A B is section of inside angle at corner post; C D is section of angle at top edge of end of box; E F is section of a side post; L M and P R are sections of end posts; and V X is a section of top edge of side of box.

The cars subjected to this examination belonged to the following six types, representative of four distinct epochs in construction:

- 1st. Cars of series L, constructed in 1861, with underframes of wood, and upperframes of iron.
- 2d. Cars of series H, constructed in 1865, with mixed underframes, and upperframes of wood.
- 3d. Cars of series L, constructed in 1865, with mixed underframes, and upperframes of iron.
- 4th. Cars of series H, constructed in 1869, with iron underframes, and iron upperframes.
- 5th. Cars of series L, constructed in 1875, with iron underframes, and iron upperframes.
- 6th. Cars of series U, constructed in 1874, built entirely of iron except the flooring.

All of these cars examined have been selected because they have not at any time been subject to modification or to extensive repairs, and have not had new parts substituted for those entering into the original construction, and because they have not suffered accidental damage more severe than they would receive in ordinary service.

CARS WITH WOODEN UNDERFRAMES AND METAL UPPERFRAMES.

The cars having their underframes of wood and upperframes of iron were built in 1861; they have consequently been in existence about 34 years. Many have already been demolished, the underframes having become useless for further service and the iron upperframes having suffered so much from oxidation as to be beyond repair. We have, in particular, examined car L 28,000, some of whose sections are given in Fig. No. 1. The areas shown in black indicate the metal lost by corrosion.

It is shown by this examination that the oxidation caused a loss of 6.04 per cent. of the weight of the frames. Unfortunately the corrosion occurred principally at certain points that affected greatly the strength of the structure, particularly in the angles girding the sides and ends at the top and the angles in the interior of the corners, nearly all of which parts at the present time require to be replaced as the cars come into the shops for heavy repairs. The expense under this head amounts to about 25 francs (\$5) per car.

Probable Life.—It is admitted that for these cars the metal upperframes in general have no greater life than the principal parts of the wooden underframes. We have no further knowledge that would justify a systematic restoration of this type. By the retention of the best of the iron sections still in service and the use in repairs of those parts still fitted for service, obtained from cars broken up, it has been possible to prolong the existence of a certain portion of the series for a period of half a score of years. Up to that time the cars decayed successively by reason of the general

corrosion of the metal upperframes, and of the bad condition of the wood underframes.

To sum up, while the adoption of iron upperframes makes a lighter car than when wood is employed, the life of the car is not materially increased. Its life varies from 30 to 40 years.

CARS WITH MIXED UNDERFRAMES.

We have examined cars with mixed underframes, numbers H 11,921 and H 12,213, having the upper frames of wood, and the cars, L 29,831, L 29,856, and L 30,314, having metal upperframes (Fig. 2). These were constructed in 1865, and are 60 years old.

The Underframes.—The sills of the frames upon examination were found to have lost 3.35 per cent. of their original weight. The loss is from the entire inner faces of the I-beams where the surfaces have seldom been painted, and from the surfaces covered by other parts. It is at the spring suspension attachment to the frame that the corrosion is most easily seen, but at no point has it become so great as to lead one to question the safety of the piece.

Upperframes.—The loss from the members of the iron upperframes of the cars of series L (series H are of wood) is much greater than the loss from the sills, particularly in the case of such parts as are situated inside of the box, or are covered by the wooden flooring. The average loss from rust was 4.32 per cent. In no one part had it become sufficient to require the replacement of the member.

Rivets and Gusssets.—The riveting in these cars is of comparatively little importance, as it is employed only in the assembling of the frames to keep the end sills and intermediate cross-ties square with the longitudinal sills. We estimate the number of rivets in doubtful condition at 15 per cent., due either to the rivets being badly placed at the beginning, the iron being burned or too cold, or because the metal was brittle through bad work or inferior material. In all cases the loss of metal from the heads by corrosion is not serious, and the loosening of the rivets by shocks and vibrations is absolutely imperceptible.

The brackets uniting the intermediate cross-ties with the longitudinal sills are still in a satisfactory state, but a great number of gusssets uniting the end and longitudinal sills had to be replaced repeatedly because of breakage in regular service.

Probable Life of the Cars.—In the cars with mixed underframes it is considered that the iron sills are yet good for a period at least equal to the time they have been in service, which would give them a total life of, approximately, 50 to 60 years. Concerning the metal upperframes of the cars in the series L, it is considered, after com-

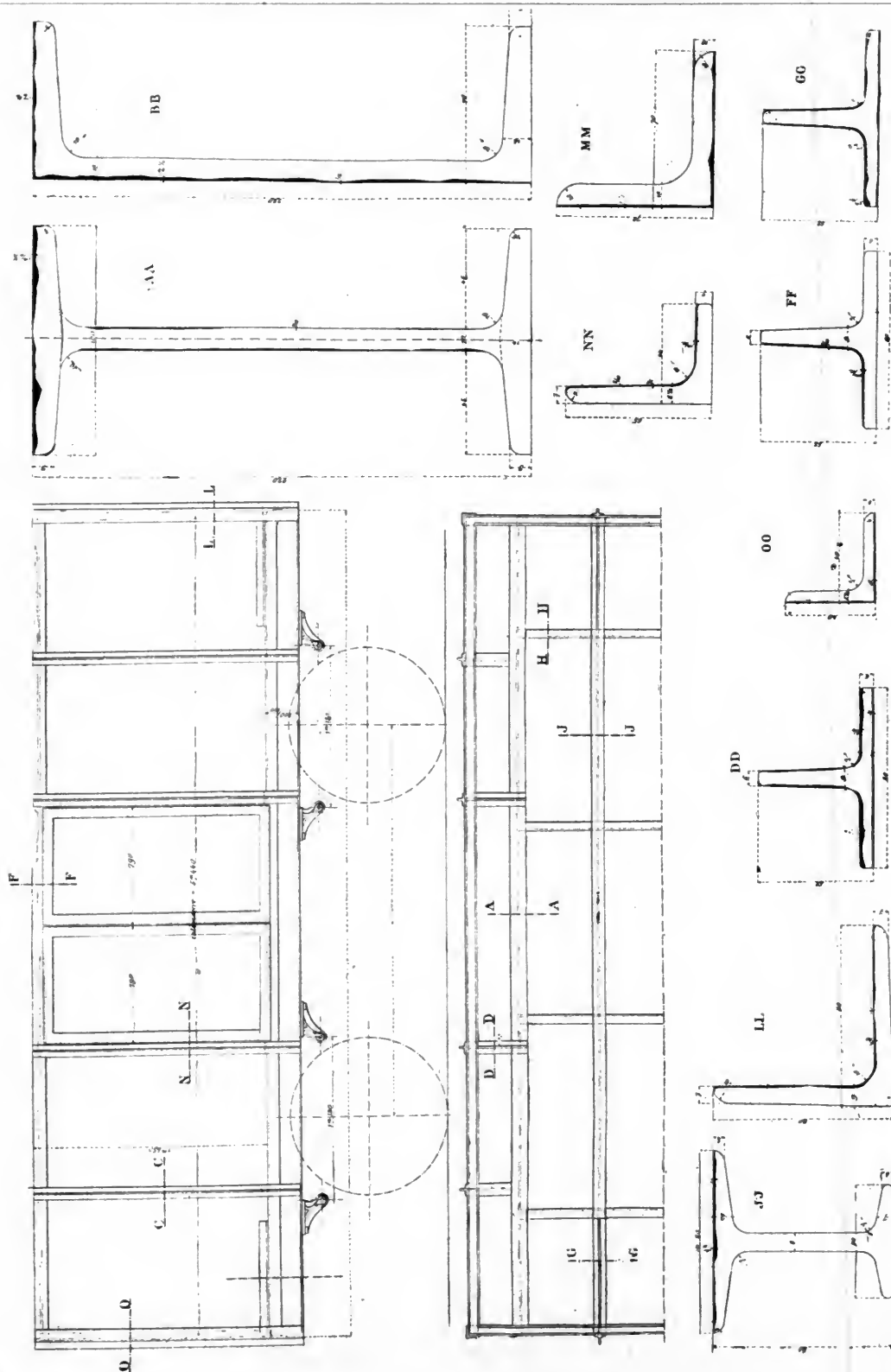


Fig. 3.—Elevation, Half-plan and Sections of Iron Members of Cars with Iron Upperframes and Iron Underframes, Built by the Eastern Railroad in France in 1869.

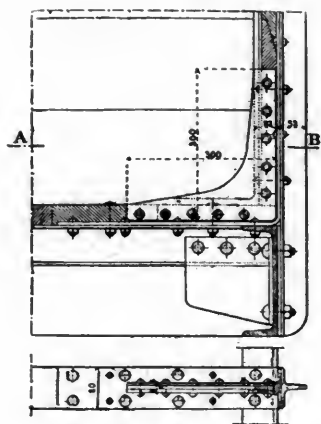


Fig. 5.

Old Construction on Cars Built in 1869.

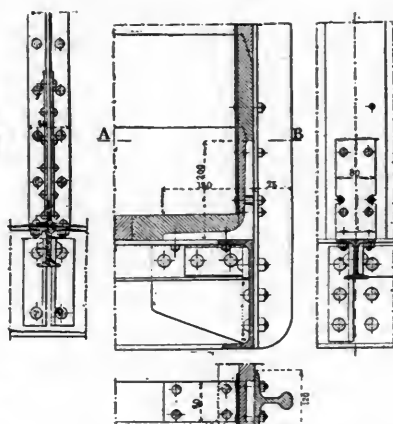


Fig. 6.

New Construction.

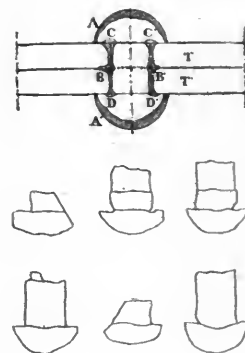


Fig. 7.

Corrosion of Rivets.

parison with similar parts of the cars built in 1861, that in four or five years it will be necessary to commence renewing some of them. By following, in the repair of these upperframes, the same method of procedure as for the cars of the year 1861, the condition of the underframes being first considered, it is believed that by spending the small sum of 25 francs (\$5) on them, the box or superstructure of the car will be good for from 10 to 15 years more of service. We estimate that at the end of that period it will be necessary either to make a new box or destroy the car. It will at that time have had a life of from 45 to 50 years, which period can be extended to 55 or 60 years by the expenditure of about 270 francs (\$54).

CARS WITH IRON UNDERFRAMES AND IRON UPPERFRAMES.

We have examined cars Nos. H 13,305 and H 13,748 built in 1869 (Fig. 3) and having therefore been in existence 26 years, and the cars L 27,621 and 30,582 built in 1875 and consequently 20 years old.

Underframes.—The loss from the iron members amounted to about 6 per cent. for the materials put in service in 1869 and 3.18 per cent. for those of 1875. It appears again, therefore, that the action of the rust is not proportional to the time, but increases more rapidly than the time. Nevertheless, it is acknowledged that in these particular cases the loss is not yet important enough to call for the replacement of any parts; and that, on the other hand, an important point relative to the losses by corrosion is the fact that in cars of the series H (year 1869) there is one more intermediate cross-tie, providing relatively more small iron work on which corrosion can act.

As in the case of the mixed underframes the loss of metal from the sills is all from the interior surfaces and those surfaces covered by other parts, notably at the top of the spring suspension brackets. The same observation is true of the end sills.

In respect to the iron floor stringers and the intermediate cross-ties these are corroded somewhat on all their faces, and in a manner proportionately more important than on the sills. These facts are an evidence of the enormous influence of the paint in preserving the iron parts of the underframes.

The Superstructure or Box.—The loss from the iron upperframes in the series H, type 1869, was about 5 per cent. In this, as in other cases, it is the metal parts inside of the box which have suffered most, particularly the gussets holding up the end posts as shown in Fig. 5. Generally these gusset plates which are only 6 millimeters (about $\frac{1}{8}$ inch) thick are so weakened that their replacement is necessary. We will also, hereafter, substitute for this assemblage of parts, which is somewhat complicated, a design analogous to that of the construction shown in Fig. 6. This modification consists in substituting for a T-iron upright or post one of a rail section and securing it by a forged knee or bracket. In our opinion, when this modification becomes general the design of the upperframe leaves nothing to be desired. The work of changing costs 150 francs (\$30) per car.

Rivets, Gussets, etc.—The iron underframes, types 1869 and 1875, it seems to us, should decay first of all about the riveting, although on four cars examined only two rivets were lost, and 10 others were loose in the holes. A separate examination of the rivets show that the corrosion is generally as indicated in the upper part of Fig. 7.

One-half of the rivets have lost 15 per cent. in weight, there being a large loss at *BB'*, probably due to the accumulation of moisture between the parts *TT*.

It is clear that machine riveting, particularly hydraulic riveting, by bringing the plates together with force at the moment of driving the rivet and in making the rivet fill the hole well reduces greatly the chances for rust at *B*, *C* and *D*, but in the old material riveted by hand it is to be feared that in several years the surfaces *CC' DD'* will have continued to corrode, and many rivets will be found loose in their holes, as we have established in a score of cases.

The heads *AA* are all more or less eaten, but it does not appear that at present they are likely to cause the loss of the rivets.

If it is considered that the oxidation of the rivets is of sufficient importance to cause solicitude, care should be exercised in the building shops in keeping the cupping tools of the riveters in shape, and guarding against the disposition of the men to repair these tools themselves, as they will grind the faces or edges, finally giving forms of rivet heads that are too much flattened.

We conclude from the results of our observations that the rivets in these cars will exhibit the defects enumerated above in the following order:

1st.—Rivets holding together the smaller parts of the upper framing. (Generally speaking these rivets are very strongly attached by corrosion; many have already been replaced in the course of current repairs and others will be as the cars enter the shops for repairs.)

2d.—Rivets in other parts of the upper frames—those which hold together the heavier parts of the frame.

3d.—Inner rivets in the gussets securing the angles of the underframes, and rivets holding the angle iron floor stringers to the intermediate cross-ties.

4th.—Rivets holding the guard plates, the corner irons—holding the cross-ties to the sills—and those securing the plates to which the drawgear is attached, etc.

The rivets in the second and third categories will be found in a poor state of preservation; we estimate that it will be necessary to replace regularly 50 per cent. of the former and 25 per cent. of the latter in each passage of the cars through the shops for heavy repairs. With this precaution, of which the cost is about 8 francs, (\$1.60) per car, the riveting of the iron underframes of these cars will suffer very little from wear and rust for a score of years. The rivets in the fourth category require as yet no attention.

The plate iron gussets have experienced a loss estimated at more than 18 per cent. of their weight. Nevertheless, as they were originally very heavy and the oxidation is chiefly outside the lines of rivets, it is to be presumed that these parts have a life equal to that of the frame as a whole.

Probable Life.—All these precautions will likely contribute to the prolongation, without accidents, of the life of these cars through a period equal to that already passed since their construction, thus assuring them a total existence of about 50 years. It appears certain that this life can be considerably increased by exercising care to prevent the action of rust.

From an examination of cars constructed in later times, it is found that the interior surfaces of the underframes commence to lose their paint at the end of three years of service. It is only then that rust begins to be produced. To avoid the rust, then, the frame

should be repainted at least once in three years. This operation, with at least two coats on the iron, will cost about 17 francs (\$3.40) including material, labor and all general expenses.

CARS ENTIRELY OF IRON.

We have examined the cars U 25,909 and U 25,902 (Fig. 4), which were built in 1874, and are consequently 21 years old.

Underframes.—The iron sections entering into the construction of the underframes have lost about four per cent. of their weight by oxidation. The corrosion is of much the same nature as in the frames built in 1875 and noted above. The examination of individual sections reveals no cause for immediate apprehension.

Superstructure or Box.—The loss from the iron plates forming the sides and ends of the box is only 1.8 per cent., and is therefore very small. The loss from the special iron sections constituting the upper frames (or frames of the box) is about 12.5 per cent., which is considerable and is explained in part by the fact that the sections are very light. We should probably attribute this to the fact that iron plates cover them and that these plates have a long life. In fact, in the case of the boxes with wooden sides, the friezes being often renewed, the irons are frequently exposed and at such times are painted, which added to their life.

The experience with the cars with boxes wholly of iron has led, then, to the singular conclusion, that the decay of these boxes is due to the destruction (by rust) of the upper frames, and it seems probable that these iron members will have to be replaced from time to time, and this work has already begun after a service of 20 years, and when the plates forming the sides and ends are yet good over all their outer surfaces.

There is a call then in cars of this type, even more than in the cars with wooden sides and ends, to employ in the framework iron sections of large dimensions.

Rivets, Gussets, etc.—The rivets of the underframes of the cars in the series U were found in practically the same condition as those

the iron frames of the cars built by the railroad company, and require the same care. This cannot be said of the rivets in the superstructure having their heads inside of the box, where they are most strongly attacked by rust; 35 per cent. of these have to be replaced each time the cars undergo heavy repairs.

REMARKS ON ALL TYPES OF CARS.

We have considered only the types of cars designated by the letters L, H and U, which are specially designed for the transportation of coal and coke. All of the other types—covered cars, series N, M, NN, flat cars, series S, I, SS, etc., are also provided with wooden, mixed and iron underframes. The results of the experience with the frames of the cars in the series H and L will also apply to these others. In regard to the superstructures of other cars we have given no attention to either flat or covered cars, as the material for the covered cars is all wood, and the side-boards of the flat cars of the Eastern Company are also of wood.

SUMMARY.

The present work presents the real difficulties to be encountered in practice, if the cars are to be so constructed as to give equal durability to all their parts.

The loss from the iron sections entering into the construction of the mixed or iron underframes is not yet very great, even for the oldest cars; but it should receive attention if the cars are to remain in service long enough to double the years they have already served. It should be the practice to cleanse and paint every three years, at least, all surfaces of the iron underframes.

The iron upperframes, without doubt, give a lighter construction to the cars, but they do not add much to the life of cars with wooden or mixed underframes. They constitute the parts most susceptible of criticism in cars of the 1869 type with iron underframes. To-day, after 20 years, upperframes require extensive repairs. It is true that the exigencies of the service of the operating department have become very great, but this is an incentive for strengthening the members of the upperframes. It should be remarked that the cars constructed after the first ten years have these upperframes made of iron or steel sections much stronger than in the earlier cars, and consequently present fewer defects than the older materials.

It is to be hoped that the machine riveting, in cases where it is employed, will prolong the life of the rivets.

For the cars 20 years old and riveted by hand, the rivets present visible traces of fatigue, but it is easy to make their life agree with that of the iron sections they hold together, by observing the precaution, each time the cars go to the shops for heavy repairs, of

replacing the worst rivets with new ones. The following proportions will serve as a basis for this substitution:

Fifty per cent. of the rivets holding together the smaller parts of the upperframes.

Twenty-five per cent. of the rivets holding together the gussets which strengthen the corners and of those connecting the floor stringers to the various transverse members.

CONCLUSION.

From all the preceding, it follows that in continuing to apply to the iron freight cars the preservative measures indicated above, which will serve to improve their condition, the Eastern Railroad of France has computed, for the cars of the old types and for the new ones, lives respectively of at least 50 and 60 years.

Air and Gas Compressors as Manufactured by The Norwalk Iron Works Company.

The present is a time of general interest in the storing and transmission of power, and the two great agents utilized for this purpose, compressed air and electricity, are attracting almost universal attention and study in the engineering and railroad world. The more careful and intelligent study thus directed to compressed air is undoubtedly responsible for much of the phenomenal increase in its use and the variety of the methods found for successfully employing it. As the problems associated with its economical compression, transmission and use are better understood and are satisfactorily solved, new adaptations for it are discovered, old uses are extended and abandoned plans revived and carried to successful conclusions. Furthermore, the great advances in general engineering have brought to the front new and heretofore unheard of conditions in certain industries, to meet which the modern high-grade compressor has been and is being extensively used. If anything more is needed to explain the increasing favor with which compressed air is viewed in the last few years it may be attributed to the perfection to which compressors have been brought by the manufacturers, though it must be stated in this connection that the latter have always led the way and been in advance of the needs of their customers.

Prominent among the builders of compressors in this country is the Norwalk Iron Works Company, of South Norwalk, Conn., who have been identified for more than a quarter of a century with nearly every important step in the improvements by which the inefficient single cylinder "wet" compressor of 30 years ago, built only for low pressures, has been developed into the excellent compound or three stage machine of to-day, adapted for pressures ranging as high as 5,000 pounds per square inch. This company was established in 1863. At that time the building of the Earle water pumps was the chief business of the plant, but a few years after the organization Mr. Ebenzer Hill, the present General Manager, became associated with the company, and he, realizing the importance of the field for compressed air and the great opportunity for improvement in compressors, directed the energies of the concern into these new channels. The success of the enterprise was so great that the construction of water pumps was abandoned long ago and for years compressors for air and gas have been the sole output of the company.

At that time air compression was in its infancy. As far as known there were no compound air compressors in use in this country, and it is said that the only one of that type running in Europe was an experimental one. Even the earliest patterns of the Norwalk company were what was known as "wet compressors" from the fact that water was used in direct contact with the air in the air cylinder to cool it during compression. But when their efforts were concentrated upon the production of compressors that were correct both in theory and in practical results, their designs were characterized by improvements on the current practice of the day, which contributed much to the high reputation they now hold. We have not the space to describe these in detail, but it is interesting to note that the concern was the first in this country to use compound or two-stage air compression and also the first to employ mechanically-actuated valves on the intake cylinders. They were also the leaders in the movement toward higher pressures, the first to make a com-

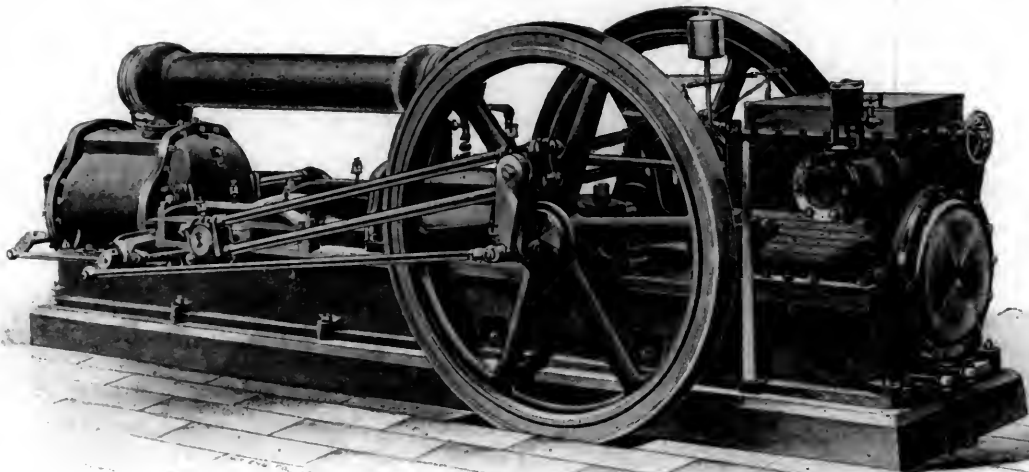


Fig. 1.—Norwalk Standard Steam Actuated Air Compressor.

mercial machine for liquifying carbonic acid gas, and to install a large plant for compressing natural gas. Such an enviable record of progress in the adoption of advanced principles and details of construction has naturally brought to the company much special work, until at the present day it is hard to say whether they are better known through their standard types of compressors or the special ones designed and built by them for unusual lines of work. Among the latter might be mentioned the air compressors for furnishing compressed air to operate the pneumatic dynamite guns of the U. S. Cruiser *Vesuvius*, which were designed to furnish air at 5,000 pounds pressure. They have also supplied the government with the compressors for the new

In this, as in all other compressors built by the company, the machine is self-contained, all the parts being mounted upon one massive bed-plate, thus avoiding out-board bearings and expensive foundations, and assuring perfect alignment. The air and steam cylinders are in line, the forces being transmitted in a direct line from piston to piston, and the steam cylinder with its high temperatures is as far removed from the intake cylinder as possible. Of course, the steam cylinder and valves can be of any good design, but in all their regular work the company use the Meyer valve gear, with cut-off valves riding on top of the main valve. The mechanism of this gear has recently been greatly simplified, and is now constructed in a manner shown most clearly in Fig. 3, which is a sectional view of a compressor similar to the one in Figs. 1 and 2, except that the steam end is compounded also. Only one larger rocker is used instead of the two formerly employed and the eccentrics are likewise reduced in number. It will be seen that the eccentric is connected to the one rocker, and through it drives the main valve, while by a large "horn" or extension of the eccentric strap the cut-off valve is driven direct. The cut-off on the high-pressure cylinder can be adjusted while the compressor is running by means of the hand wheel on the extension of the valve rod.

Before leaving Fig. 3 we would state that in compressors having the steam end compounded, the pistons and cylinder heads are so arranged that both of the former can be removed through the low-pressure cylinder. This cylinder does not have to be removed to get at the interior of the high-pressure cylinder. By an ingenious arrangement one gland and packing makes the piston rod steam-tight between the two cylinders.

Turning from the steam end we find the intake and high-pressure air cylinders are in line, with the crosshead between them. This crosshead is a wide one with pins at its ends for the connecting rods that lead to the cranks on the fly-wheel shaft. The piston rods are not connected directly to the crosshead, but are both keyed to a block held in the crosshead by the vertical pin shown in Fig. 3. This permits the crosshead to swivel slightly and thus adjust itself to the length of the connecting rods without straining the piston rods. There is also a slight vertical adjustment provided by means of this same block to compensate for the wearing down of the crosshead and guides.

In a steam cylinder using steam expansively, the greatest force is exerted during the early part of the stroke, while in an air compressing cylinder the power required is largely in the second half. Instead of providing heavy fly-wheels to absorb and give out power in different parts of the stroke, the inertia of the reciprocating parts is utilized for this purpose. The piston rods

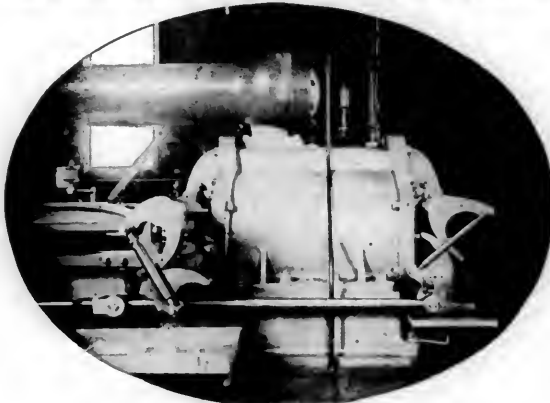


Fig. 2.—Valve Gear on Intake Cylinder.

monitor *Terror* on which air is used for raising ammunition, moving turrets, etc. Other special uses, such as for disappearing gun carriages, compressing hydrogen to 2,000 pounds pressure, the compression of illuminating gas for storage, etc., might be noted, but it will suffice to say that the company has been and is now ready to undertake any special work involving any pressure that can be successfully utilized after leaving the compressor.

While much of this special work carried on by the company would be of great interest to our readers, the limits of our space compels us to be content with a reference chiefly to their standard types. The first of these to which we would call attention is their standard steam actuated compound air compressor shown in Figs. 1 and 2.

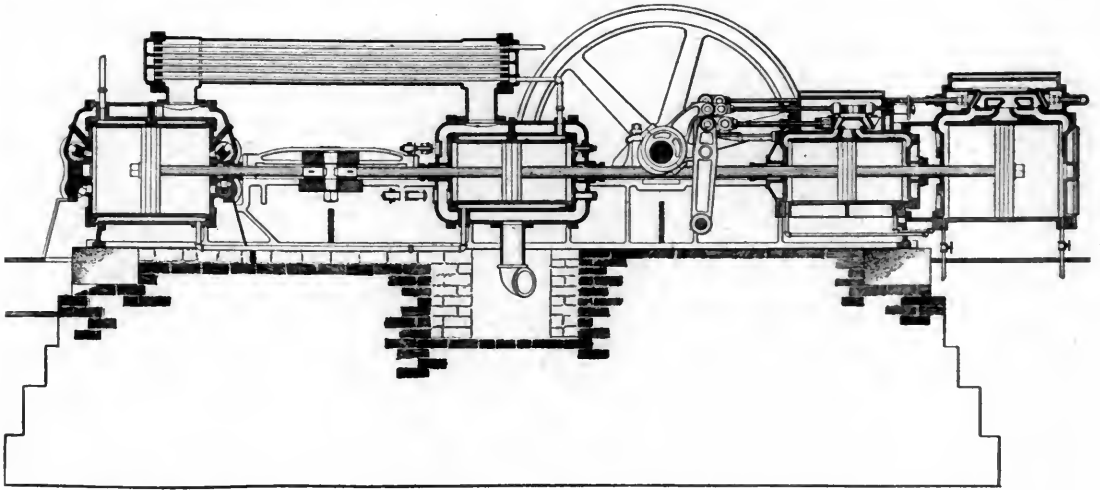


Fig. 3.—Sectional View of Norwalk Compound Air Compressor Driven by a Compound Steam Engine.

and crosshead represent in the aggregate considerable weight, so that it requires most of the power of the steam over and above the air resistance at the beginning of the stroke to start them forward at the required speed. At the end of the stroke, when the steam has become weak by expansion, the power stored up in the momentum of these reciprocating parts is given out in useful work, and the parts are brought to a state of rest by expending their force upon the air in the compressing cylinders. The weight of these parts is purposely made sufficient to give the desired result, consequently the flywheels can be made comparatively light and there are no heavy strains to be transmitted between them and the pistons.

The valves on the inlet cylinder are of the Corliss type, and it will be seen that both inlet and discharge valves are mechanically actuated. The selection of inlet valves of this type was made after a careful investigation of all other forms. Poppet valves are a source of loss from their resistance to opening. It has been found that to make poppet valves operative at all reasonable speeds and conditions, the springs on them must have a force equal to at least eight ounces of air pressure per square inch of valve area. Small as is this pressure, it considerably reduces the amount of air taken in at each stroke, compels the compressor to be run at a higher speed to deliver a given quantity of air, and

altogether causes a loss which is not less than 4.8 per cent. and may be more if the conditions are unfavorable. Furthermore, these Corliss valves permit the air to enter the cylinder in large streams and reduce to a minimum the heating of the air from passing over heated metallic surfaces. To further insure the en-

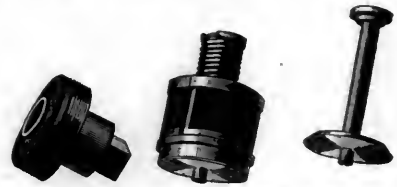


Fig. 4.—Norwalk Poppet Valves.

trance of cool air at the intake cylinder, it is recommended that the air be taken from a cool place outside of the engine-room and led to these valves through wooden conduits, for the attachment of which to the cylinder heads provision has been made. As showing the importance of cool air for compression we present the following table, in which is tabulated the discharge of a com-

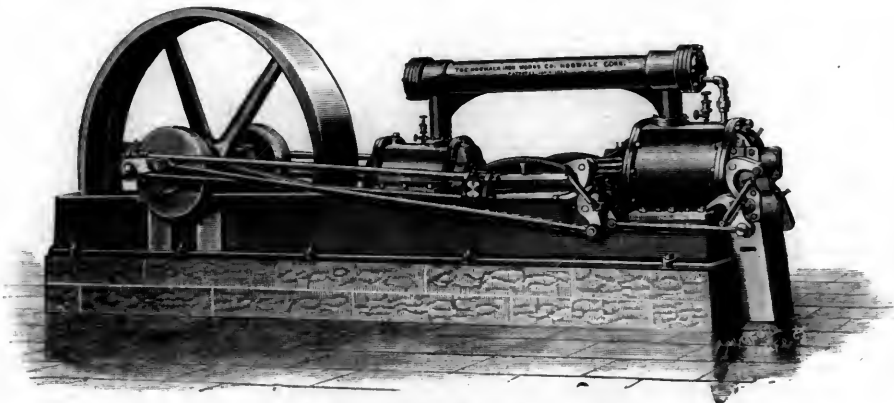


Fig. 5.—Norwalk Belt-Driven Compressor.

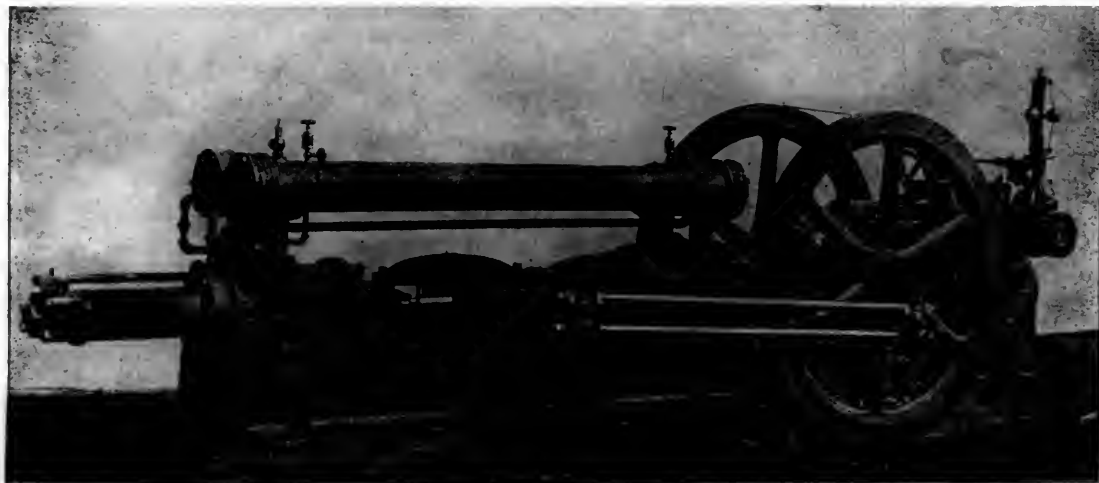


Fig. 6.—Norwalk Compressor for Carbonic Acid Gas.

pressor having an intake capacity of 1,000 cubic feet per minute, for several different temperatures at the intake:

Temperature of intake air.	Volume taken into compressor.	Volume discharged if measured at 62 degrees and atmospheric pressure.
0	1,000 cubic feet.	1,135 cubic feet.
32	1,000 "	1,060 "
62	1,000 "	1,000 "
75	1,000 "	975 "
80	1,000 "	966 "
90	1,000 "	949 "
100	1,000 "	932 "
110	1,000 "	916 "

The above tabulated gains and losses are due to changes in temperature only and have no bearing whatever upon the power needed to work the compressor. The temperature of the intake air does not change the power needed to operate the machine. The resulting efficiency is changed as above shown.

In a compound or two-stage compressor the point at which the discharge valves of the first cylinder should open is fixed by the ratio between the cylinder volumes, and advantage is taken of this fact to give such valves a positive motion. The valve

mechanism on this cylinder of the Norwalk air compressor is ingenious. It can be seen best in Fig. 2. The intake valves are driven direct by a connection to a return crank on each end of the fly-wheel shaft, and the discharge valves are opened by means of peculiar shaped cams on the stems of the inlet and discharge valves. These cams allow the discharge valves to stand still during a large part of the stroke and at a time when the pressure in the cylinder is much less than that on the other side of the valve, and then they rapidly open the valves when the air in the cylinder has about reached delivery pressure and the valves are almost in perfect balance. This reduces to a minimum the wear on the valves and valve mechanism and reduces greatly the power required to operate them. The discharge valves are closed by the spring connection between the cams.

The air after passing through the intercooler is admitted into the second cylinder by poppet valves. These and the outlet valves of the same type are placed in an accessible position in the cylinder heads, and are carefully designed. The valve, valve

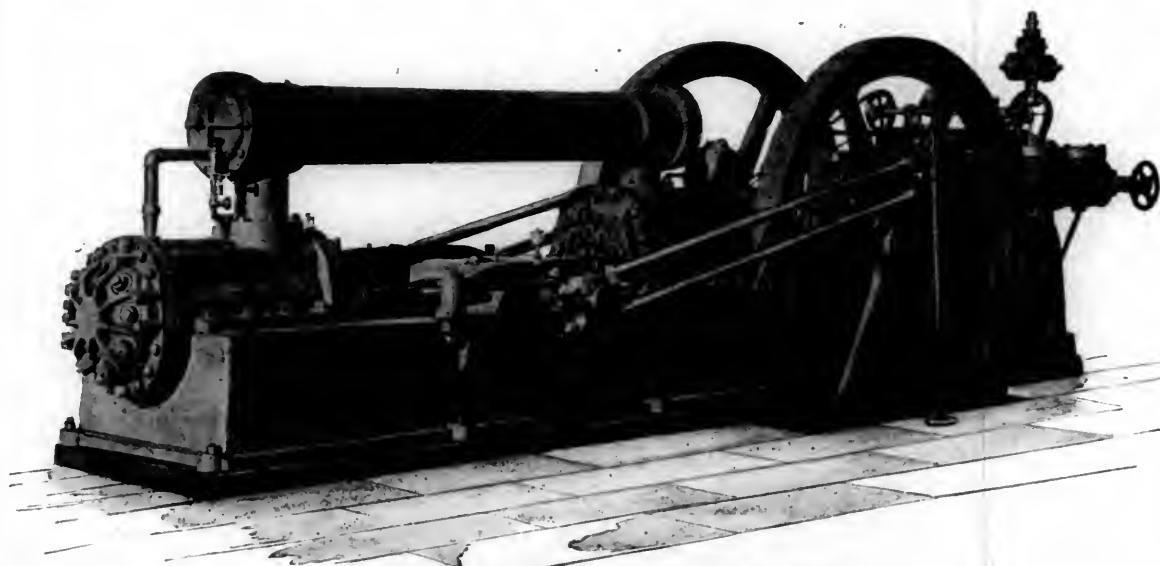


Fig. 7.—Norwalk Compound Compressor for Natural Gas.

stem and head are all forged in one piece, as shown in Fig. 4, so that there are no stems, nuts or split pins to get loose. To permit of this construction, the guide for the stem is made in halves and secured by the seat itself, while the spring is turned into proper position under the head in much the same fashion as a corkscrew is worked, the wire of the spring passing through the small score in the head of the valve seen in the middle view in Fig. 4. The neatness of the arrangement has to be seen to be fully appreciated. This same valve is used in the company's gas machines.

The arrangements for cooling the air are deserving of attention. These consist of jackets on both cylinders and an efficient inter-cooler. The importance of proper cooling can be better realized when we consider the heat of compression. The extent of this for ordinary pressures can be seen from the following statement of the final temperatures of dry air compressed without any cooling whatever :

Temperature of air before compression.	Degrees. 60	Degrees 90
Pounds.		
Temperature of air compressed to....	177	212
“ “ “ “ 30	255	294
“ “ “ “ 45	317	362
“ “ “ “ 60	369	417
“ “ “ “ 75	416	465
“ “ “ “ 90	455	507
“ “ “ “ 105	490	545
“ “ “ “ 120	524	580

Perhaps the part this heating plays in work of compression will be better understood from a practical example. Air compressed to 5 atmospheres, or 60 pounds pressure on the ordinary gage, in a compressor without cooling arrangements, would be raised in temperature from 62 degrees to 373 degrees Fahrenheit. Assume that the amount of air is such that it requires an engine of 100 horse-power to do the work. If now a *perfect cooling* apparatus be added to the compressor, the power required would be reduced from 100 down to 78.4 horse-power. In other words the value of a perfect cooling apparatus to that compressor would be 21.6 horse-power. So much cooling cannot be obtained from a single cylinder jacket. In a compound compressor doing the same work the temperature of the air on leaving the first cylinder would be 199 degrees, if the cylinder had no jacket. All this heat above the atmospheric temperature can be taken out in the intercooler. By thus cooling the air the original 100 horse-power required will be reduced to 83.1 horse-power. But we have seen that by perfect cooling another gain of 9.7 horse-power is possible. To effect this a water jacket is put on each of the two air cylinders. In this manner a large part of the gain from cooling is made sure by using an intercooler, and of the remaining gain which is theoretically possible, as much as possible is realized by the use of cylinder jackets.

In the Norwalk compressor the jackets are formed by bushing the cylinders, the main casting being so formed as to leave an annular space around the bushing when the latter is in place. This is a more reliable construction than casting the cylinder all in one piece, as there is no danger from misplaced cores. It also permits the use of a harder and better wearing material in the bushing, and this opportunity is not neglected by the company. The intercooler is the cylindrical chamber mounted on top of the air cylinders and is made of ample volume to give time for complete cooling. The cooling water circulates through numerous pipes to pass which the air must be divided into many small streams.

As already stated, the company are firm advocates of the compound compression, and were the first to employ it in this country. The reasons for their practice have been given in the foregoing, where the gain in efficient cooling was illustrated. Such cooling cannot be effected in a single cylinder by means of one water jacket. Furthermore, there is more uniform resistance throughout the stroke in two-stage than in single cylinder compression. At the same time they build many single compressors for such work as they are adapted to.

We have thus far confined our attention to steam actuated air compressors with either single or compound steam cylinders according to the steam pressure available. The company also build

belt driven compressors of the type shown in Fig. 5, in which all the economies at the air cylinders are realized as fully as in the machines already described. For utilizing water power a similar compressor is built in which a Pelton or other water wheel takes the place of the belt wheel shown.

Mention has already been made of the compressors built for compressing and liquefying carbonic acid gas. One of these machines is shown in Fig. 6. The gas first enters the large cylinder through the opening shown, and after compression passes through one of the two intercoolers, thence into the second cylinder, next into the other intercooler, and then into the small cylinder to the extreme left. The first cylinder is double-acting and the others single. The pressure required for liquefaction is of course dependent on the temperature and is in usual practice about 1,200 pounds. The cylinder head on the last cylinder is made of forged steel, and it is found that cast metals are too porous for the pressure. The air cylinders cannot be lubricated with oil because the gas must not be contaminated in the least, and special devices are resorted to for producing frictionless movement.

In Fig. 7 we give a view of one of several compound compressors built for compressing natural gas for the city of Tiffin, O. Each of these compressors is capable of delivering 5,000,000 cubic feet of gas per day through 80,000 feet of 8-inch pipe. These machines differ slightly from the company's regular design of compound compressors in having the large intake cylinder, which is subjected to the lightest pressure, in the middle of the machine. This was done in order that the second or high-pressure cylinder could be thrown out of gear until the changing condition of the field required its use.

One of the largest natural gas pump installations supplied by the company is at Greentown, Ind., where the compressors send the gas to Chicago, 116 miles, through two lines of 8 inch pipe. Last winter the plants equipped with Norwalk compressors averaged a delivery of 100,000,000 cubic feet per day. In some of these natural gas plants the conditions are such that single cylinder compressors are best suited to the requirements and the company has installed a number of these machines at various places.

Several railroads have used ordinary illuminating gas for car lighting and in such cases have needed compressors for that gas. The Pennsylvania Railroad and the Philadelphia & Reading Railroad are using Norwalk compressors for this purpose. The Pennsylvania Railroad has all told 21 Norwalk compressors in service.

There is an attraction about large machinery that captivates many, but this company, though prepared to build compressors of almost any size, do not generally advocate anything larger than 82 inches by 36 inches, believing that in the average large plant it is wiser to adopt approximately that size for each unit and increase the number of units until the desired total capacity is obtained. The workmanship entering into the Norwalk compressors is in keeping with their excellence of design, and whenever the company is acquainted with the exact needs of a customer, a compressor is built which exactly fits those requirements. In conclusion, we would say that those who want to know more about Norwalk compressors or the general principles underlying air and gas compression, should write for one of the company's catalogues. This book is almost a scientific treatise on compressed air, so full is it of valuable information on this subject.

According to the *Railway Age and Northwestern Railroader* the new railroad construction for the first six months of this year is 717 miles, as against 622 miles for the same period in 1895, 495 in 1894, 1,025 in 1893, 1,284 in 1892, 1,704 in 1891, and 2,055 miles in the first half of 1890.

The big steamer building at the Vulcan yard, Stettin, Germany, for the North German Lloyd Company, and which is to compete with the famous Cunarders *Campania* and *Lucania*, will be 625 feet long, 66 feet beam, and 43 feet deep, and her engines will develop 28,000 horse power. A similar ship is also being built at the works of Mr. Scichan at Dantzig. Another of the big German shipping corporations, the Hamburg-American Company, is having built at Harland & Wolff's yard, Belfast, Ireland, a steamer that will be the biggest freight carrier in the world. Her dead weight will be over 12,000 tons and her dimensions are 560 feet long, 62 feet beam and 41 feet deep.

(Established 1832.)

AMERICAN ENGINEER CAR BUILDER AND RAILROAD JOURNAL.

27TH YEAR.

65TH YEAR.

PUBLISHED MONTHLY

BY

R. M. VAN ARSDALE,

MORSE BUILDING.....NEW YORK.

M. N. FORNEY,
W. H. MARSHALL, } Editors.

R. G. CHASE, 705 Western Union Building, Chicago.

AUGUST, 1896.

Subscription.—\$2.00 a year for the United States and Canada; \$2.50 a year to Foreign Countries embraced in the Universal Postal Union.

EDITORIAL ANNOUNCEMENTS.

Advertisements.—Nothing will be inserted in this journal for pay, EXCEPT IN THE ADVERTISING PAGES. The reading pages will contain only such matter as we consider of interest to our readers.

Special Notice.—As the AMERICAN ENGINEER, CAR BUILDER AND RAILROAD JOURNAL is printed and ready for mailing on the last day of the month, correspondence, advertisements, etc., intended for insertion must be received not later than the 25th day of each month.

Contributions.—Articles relating to railway rolling stock construction and management and kindred topics, by those who are practically acquainted with these subjects, are specially desired. Also early notices of official changes, and additions of new equipment for the road or the shop, by purchase or construction.

To Subscribers.—The AMERICAN ENGINEER, CAR BUILDER AND RAILROAD JOURNAL is mailed regularly to every subscriber each month. Any subscriber who fails to receive his paper ought at once to notify the postmaster at the office of delivery, and in case the paper is not then obtained this office should be notified, so that the missing paper may be supplied. When a subscriber changes his address he ought to notify this office at once, so that the paper may be sent to the proper destination.

The paper may be obtained and subscriptions for it sent to the following agencies: Chicago, Post Office News Co., 217 Dearborn Street. London, Eng., Sampson Low, Marston & Co., Limited St. Dunstan's House, Fetter Lane, E. C.

CONTENTS.

ILLUSTRATED ARTICLES:	Page.
The Altoona Shops of the Pennsylvania Road.....	165
Vauclain Compound Passenger Locomotive for the C. & M. & St. P. Ry.....	170
The Preservation, Maintenance and Probable Durability of Rolling Stock with Metal Underframes and Metal Upperframes.....	171
Air and Gas Compressors as Manufactured by the Norwalk Iron Works Co.....	177
Speed Control of Modern Steamers.....	187
The Most Advantageous Dimensions for Locomotive Exhaust Pipes and Smokestacks.....	190
The Brill Truck for Passenger Cars.....	193
Origin of Pneumatic Tires.....	194
Test of Boilers.....	195
Locomotive Steam Pipes.....	199
Exhibit of Root's Steam Boiler at the National Electrical Exposition.....	200
EDITORIALS:	
Altoona Shop Articles.....	182
Pure Feed Water for Boilers ..	182

Heating Buildings by Waste Heat.....	182
Interchange Rules and the St. Louis Tornado.....	182
Oil and Gas Engines.....	182
Steel Underframes for Freight Cars.....	183
MISCELLANEOUS:	
Engine Power and Self Propelled Road Traffic.....	170
Engineering Notes.....	184
Personals.....	185
Equipment Notes.....	186
New Publications.....	186
Books Received.....	187
A Water Power and Compressed Air Transmission Plant for the North Star Mining Co. Grass Valley, Cal.....	188
Railroad Master Blacksmith's Ass'n.....	194
The Freezing of Gas.....	195
Trade Catalogues.....	196
Master Car Builders' Ass'n Reports.....	198
Master Mechanics' Ass'n Reports.....	199
Manufacturing Notes.....	201
Directory.....	202

The June number of the AMERICAN ENGINEER, CAR BUILDER AND RAILWAY JOURNAL, contained the first of several articles on the Altoona shops of the Pennsylvania Railroad. The convention held in Saratoga in June supplied so much material for the July number of the paper that the second article on Altoona was omitted from that number and now appears in this one. The points of interest which may be observed in Altoona are almost limitless, and the series of articles might be continued indefinitely. The article in this number will be succeeded by several others.

There is hardly such a thing as absolutely pure water obtainable for feeding steam boilers, and as the consensus of opinion seems to be that it is not fit for use in boilers anyway, it is probably fortunate that it is so rare. Apparently pure feed water is found to corrode sheets and flues for some reason not quite clear, and the thinnest of lime scale is found to protect the surfaces from this action. Hence, while very impure waters are to be avoided and the formation of scale reduced to a minimum, feed waters being purified if the conditions are serious enough to warrant the cost of the process, information at present available points to the fact that it is not necessary or even advisable to seek a water absolutely pure or to remove the last grain of lime by a purifying process.

The heating of buildings by means of the waste heat of a steam plant is one of the favorite ways of utilizing heat that would otherwise be a total loss. This is usually done by a use of the exhaust steam from the engine when it is non-condensing, but there was recently published the description of a plant in which the heat is abstracted from the water discharged from the hot well of a condensing engine, and employed to raise the temperature of the air in a hot-blast system, while the air currents generated by the flywheel of the engine are utilized to force the hot air through the ducts. In the case of mills the engines are so large in proportion to the buildings they serve that the heat available is sufficient for the purpose, and in many manufacturing establishments this condition will also obtain. Where such is the case, the system appears to have advantages as the larger heating surface required in the heaters, with its attendant cost and greater space occupied, will be more than offset by the smaller consumption of power.

The tornado at St. Louis has raised an interesting question regarding the limits of responsibility under the Master Car Builders' rules of interchange. These rules say that cars must be returned in as good running order as when received, and the various roads signing the code have agreed to do this. But when property is destroyed by what is in legal phraseology termed an "act of God" the courts will not compel the payment of damages. Some of the roads entering St. Louis were willing to repair at their own cost foreign cars on their tracks damaged by the tornado, while others refused to do so. Some of those refusing did so on the ground that while they might be willing to pay the costs in this case if others signing the code of rules would do likewise in the future, there was no guarantee that such costs could be collected in this or in future cases, nor was there any redress obtainable by taking a future case into the courts. In other words, while the framers of the code of rules might not have so meant it, these rules go further than does the law and involve obligations not recognized in the courts; hence a settlement of this case under the rules would not be fair to the parties interested unless they were assured that in the future the rules would not be repudiated and the protection of the courts sought by those on whom the obligations would fall. There was to be a meeting held in July of those interested at St. Louis to decide upon the course to be pursued, but at this writing we have not learned the results of the conference.

That oil and gas engines are certain to claim part of the field now occupied by the steam engine is susceptible of new proof almost daily. The advantage of economy in small powers, or, in fact, in all powers in which they are as yet built, is with the gas and oil engines, and in many applications the less bulky fuel, the absence of ash, the greater quickness with which the gas engine

can be started, the fact that there is no boiler requiring attendance either while the engine is running or after it is shut down, are all in their favor. One of the latest and most novel applications of the oil engine is on one of the lightships of the United States Government. Here it is made to run an air compressor to supply air for the large whistle used as an audible signal in foggy weather, and one of its great merits in this case is in the fact that it can be started at once when a fog approaches, while with the steam engine there was a boiler to be fired up before power was available. Railroads are also finding a use for these engines at isolated water stations, where a great saving in attendance is found. In fact, wherever the service is intermittent in character the gas and oil engines are doubly advantageous. In many cases, however, where a regular service is desired, the gas engine holds its own and asks no favors of the steam-engine. Unfortunately gas engines have in the past been expensive in the matter of first cost, even costing as much as a steam-engine and boiler of the same power, but the cost is coming down and with the increased demand for them there are opportunities to still further reduce their cost. When this has been accomplished to a sufficient extent the steam-engine will be supplanted to a greater degree than at present.

STEEL UNDERFRAMES FOR FREIGHT CARS.

If we read the signs of the times rightly, the substitution of steel for wood in the construction of freight cars, particularly in their underframes, will make material progress in the near future. The reduced cost of steel and the increasing capacity of cars are both favorable to the change, and steel is being considered by enterprising railroad officials; there is at present a better prospect for a thorough trial of the metal construction than at any time in the past. It is hardly to be expected, however, that great numbers of steel cars will be built immediately, or that the experiences of the near future will be limited to a few designs only. The practical experience of the past has not been such as to converge opinion in favor of any one type; on the contrary, it has left the field open to the invasion of any meritorious design. This condition of affairs is most favorable to those who have special or patented constructions to present to railroad officials, but it is puzzling to the latter, as it is difficult to select from those available a design that shall be put to the test of regular service, without some practical data as a guide in making the selection—data which is not at hand and cannot be obtained by a brief test of a sample car. Designs must be chosen, therefore, by the best judgment that can be exercised without the aid of such data.

Among those who have carefully considered the problems of steel-car construction the question which presents itself for solution is not how the car shall be made to carry a certain load, but rather what are the essential features of a design that shall embody the minimum of weight with the maximum of durability under the action of corrosion, the shocks and complex strains of service and the occasional damage from wrecks, and which shall at the same time be easy to repair when repairs are needed? In other words, the building of steel cars, or cars with steel underframes, is a matter of cost—not the first cost only, but the total cost during the life of the cars. Hence those who contemplate giving them a trial, while not unmindful of the first cost, are naturally desirous that the design selected by them shall ultimately yield the most satisfactory answers to such questions as How long will the cars last? What will it cost to maintain them? How will they go through wrecks? Will bolts and rivets get loose and cause trouble and expense? How can corrosion best be prevented and its effects minimized? While the answers to these questions cannot be drawn from present experience in this country we think there is every reason to believe that when the answers are forthcoming they will be decidedly favorable to the cars with well-designed steel underframes.

As we have not any extensive experience in America on which to draw at this time, our readers will doubtless be interested in an article on another page of this issue, in which is related an experience of 35 years with iron and steel in car con-

struction on the Eastern Railway of France. The freight cars in use on that road are small in comparison with American cars; they are carried on four wheels and are undoubtedly subjected to less rough usage than our cars, and yet there is much valuable experience there related, which will be a help to officials here in deciding upon designs for their cars. Briefly stated, the experience of the Eastern Railway is that while wooden underframes have a life of from 25 to 30 years, the metal underframes of similar cars, after 20 years of service, are in such excellent condition that their total life is estimated at from 50 to 60 years; that the upperframes, when made of iron, being of much smaller sectional areas, will corrode more rapidly and will not last more than 30 years; that the riveting, if of good design and workmanship, will not become loose from shock or vibration, and that serious corrosion in the rivet holes can be prevented by making the rivets completely fill the holes, machine riveting being preferred to hand riveting for this reason; and that the evils of corrosion can be greatly reduced by painting the metal work at least once in three years.

As we have already intimated, the experience of railways in France may not be in all respects directly applicable to conditions in this country, but a number of conclusions valuable for general guidance would appear to be warranted, the first of which is that properly designed steel underframes will last at least twice as long as underframes of wood. Wooden frames in France have apparently a longer life than in this country. Here many place the average life of a freight car at not more than 15 years, but there is good reason to believe that the true figure is nearer 20 years, while French cars of the type investigated last 30 years. As the French underframes of iron have double the life of the wooden ones, and as there do not appear to be any service conditions here particularly prejudicial to metal frames, it is reasonable to expect that the use of steel will double the life of the underframes of American cars. In fact, there is good cause for believing that in this country the life will be more than doubled. In the first place, our cars carry from three to six times as much load as French cars. This means heavier cars with larger steel sections in their frames. These larger sections will suffer from less corrosion, admit of more substantial construction at the riveted joints, and in every way tend to increased life. The only offset to this is the rougher handling of the cars in this country, and even in this respect the difference is more apparent than real, for the heavier and stronger frames required for the heavier loads are better adapted to resist the effects of rough handling. All things considered, therefore, it seems justifiable to conclude that the average life of steel underframes in this country will be at least double that of wood, or, in other words, will exceed 40 years, and that if proper precautions against corrosion are taken this period may be greatly increased.

The second lesson that can be drawn from the condition of the French cars is that, other things being equal, a frame composed of few pieces, and these of relatively large sections, will last longer than a frame having a larger number of smaller parts. The former is also commendable for its simplicity, the reduction of riveted work, and the accessibility of its parts. Such a frame will not only resist the action of the elements better, but it should prove lighter on repairs, less liable to damage in a wreck, and more easily put in shape when damaged.

Another point that should not be lost sight of is the fact that good riveting will not give any trouble in service. It will not loosen from shock or vibration, nor will it corrode if the rivets fill the holes completely. The importance of the rivets filling the holes was brought out by several who took part in the discussion on steel underframes at the M. C. B. convention in June, and need not be enlarged upon here. It is well to point out, however, that the experience of the French does not lead them to consider for a moment the use of bolts instead of rivets.

If we could have given space to all of the engravings which appeared in the original of the article we have translated, the influence of paint as a preservative against rust would be more striking. In the underframes, the corrosion is greatest on such surfaces as are covered by other parts, more particularly those covered by the flooring. Next in order are inner surfaces, not

covered, but difficult to reach with a paint brush; and finally there are the exterior surfaces, easily accessible, and almost free from corrosion. It would appear to be a wise precaution to so make steel underframes that when the flooring is being renewed the entire frame could be laid bare, cleaned and painted.

There is not much encouragement for metal upperframes in the article we are discussing. Because of the small sectional area of the various parts, corrosion is an important factor, and they have no longer life than the wooden frames. In this country, the greater size of the cars would permit of heavier sections being employed in the upperframes, from which a greater life might reasonably be expected. But there is little inclination to use metal upperframes in the United States at present, attention being devoted chiefly, and, we think, wisely, to the underframes. As regards the latter, the experience in France, Germany, India or other countries where they are used is unreservedly in their favor.

It is to be noticed that not a word is said regarding the difficulties of conducting repairs in metal instead of wood. And yet French railway officials had to meet the same conditions as our master car builders must face in introducing the steel frames. Twenty-five years ago they were using wood exclusively, and now they are using iron almost altogether; they had to accept new conditions and methods for making repairs, and as there is not a word about trouble during the transition, we can only conclude that the difficulties experienced were not as great as some officials in this country expect them to be here.

Another strong testimonial in favor of the steel underframes and the low cost of repairs comes from the few roads in this country that have had any experience with well-designed frames in regular service. The Norfolk & Southern road, for instance, finds that the cost of repairs for the four years it has used steel underframes is practically nothing. It certainly appears that repairs to steel cars will come so slowly and be so small that the problem of making such repairs cheaply can be solved leisurely.

Whether it is better to begin with mixed underframes and afterward take up frames entirely of steel admits of two opinions, but we firmly believe that the better way is to go to all-steel underframes without any intermediate steps. As to the question of special and patented sections versus regular structural shapes, a decision will be reached only after experience with both. Some of the cars constructed from special shapes already brought to the attention of railway officials are admirably designed, but before they will be adopted to any large extent they will undoubtedly be called upon to compete with cars constructed of regular structural shapes. It will then be a survival of the fittest. It would appear that in the designing of steel underframes there is a chance for the mechanical department and the chief or bridge engineer to work together. The latter ought to be able to render valuable assistance.

NOTES.

For five summers the Baltimore & Ohio has been compelled to haul water in tanks from the Ohio River to supply its locomotives in West Virginia, where the mountain streams give out in dry weather. To avoid this a reservoir with a capacity of 3,000,000 gallons is building at Glover's Gap, W. Va. The water will be furnished by artesian wells, several of which have been drilled in the vicinity. On the Pittsburgh Division, near Triadelphia, a similar but smaller reservoir is being built for the same purpose.

The Royal Agricultural Society will hold its 1897 meeting at Manchester, England, when prizes of \$500 and \$250 are offered for the best self-moving vehicle for light loads, and similar sums for the best heavy self-moving vehicle. Those of the former class are to be designed for loads up to 2 tons, and the latter for loads of 5 tons, the weight of the vehicle itself being excluded. Where petroleum is used, the specific gravity of the oil must not be less than .8, and the flashing point not less than 73 degrees Fahr. The trials will consist of a run of 30 miles and return, and careful measurements of fuel and water consumed will be made. The maximum speed is placed at 10 miles per hour. Entries must be re-

ceived before April 1 next, and may be sent to Mr. Ernest Clarke, 13 Hanover Square, London, W., from whom further information can be obtained.

The United States Lightship Board recently installed a unique signaling plant on Lightship No. 42, stationed off Cape Cod. The boat's visual signals consist of fixed white lights in gratings at the two mastheads, and its audible signal is an immense whistle operated by compressed air. Power for compressing the air is furnished by two Hornsby-Akroyd oil engines of 25 horse power each. These engines can be started up in from 10 to 15 minutes, and as compressed air is always kept stored in reservoirs of sufficient capacity to run the whistle for 20 minutes, the whistle is ready for service at a moment's notice in case of sudden fog. The air is compressed to 60 pounds pressure and passes through a reheater and a reducing valve before going to the whistle. The reheating is done on the score of economy and also to prevent the whistle from clogging with the frost and ice that would otherwise be formed by the cooling effect of the expanding air.

The *Monthly Bulletin* of the Bureau of American Republics for June has an article on the railway systems of the Argentine Republic in which the total railway mileage is given at 14,029 kilometers (about 8,760 miles); of this total five lines are the property of the nation with a length amounting to 1,026 kilometers; 10 lines with a total length of 3,834 kilometers are guaranteed by the Government; seven lines of 6,241 kilometers are without national guarantee, and seven lines, comprising 2,928 kilometers are subject to provincial jurisdiction. In 1894 there were in service 1,112 locomotives, of which 868 were of English manufacture, 144 American, 68 French, 12 Belgian, 9 Canadian, 2 German and 4 of home manufacture. There were 1,456 passenger coaches, of which 824 were of English manufacture, 235 American, 184 Argentine, 92 French and 121 the manufacture of which is not given. There were 31,039 freight cars, 17,940 of which were of English make, 6,421 Argentine, 1,496 American, 1,265 French and 3,917 not stated.

The United States navy is not the only one in which there is dissatisfaction because of improper treatment of the engineer officers. In the British navy the same trouble exists and in the hope of educating public opinion to an appreciation of the injustice systematically dealt out to the engineering staff, *The Practical Engineer* began in its issue of May 15 a serial story entitled "The Naval Engineer and the Command of the Seas." In the course of the story war is declared between England and France and the first naval engagement takes place in the Mediterranean, and is described in an interesting manner. The battle might have terminated in favor of the English had not a second French fleet appeared upon the scene, compelling the English to beat a retreat. The importance of the work of the engineering staff is brought out in connection with the maneuvers of the vessels, and the appearance of the second French fleet is attributed to the impossibility of getting engineers and artificers to man a sufficient number of British men-of-war to keep the Frenchmen in port. As a story it is thus far quite interesting, and it is to be hoped it will serve a useful purpose.

One of the new fast passenger engines on the Chicago, Rock Island & Pacific Railway made an excellent run from Chicago to Rock Island on June 3. The run of 181.3 miles was made in 3 hours and 28 minutes, the train making seven stops and seven times slowing down to 25 miles per hour in passing over interlocking plants and bridges. Furthermore, 31 minutes was consumed in going the first 15 miles, because of the difficulty of getting out of the city over the tracks which are being elevated. That leaves only 2 hours and 57 minutes for the remaining 166.3 miles, making the average speed for that part of the run 56.37 miles per hour, including the seven stops and seven slow-downs. The train consisted of five cars, weighing 452,170 pounds, or over 226 tons. The new engines are known as "Class 22 A," and are of the eight-wheeled type. They have cylinders, 19½ by 26 inches; driving-wheels, 78 inches in diameter; radial-stay wagon-top boilers, 61 inches in diameter at the smallest course; total heating sur-

face, 1,989.3 square feet; grate area, 2.45 square feet; boiler pressure, 190 pounds; driving wheel base, 8 feet 6 inches; total wheel base of engine, 28 feet 1½ inches; weight on drivers, 83,000 pounds; weight on truck, 42,000 pounds; total weight of engine in working order, 125,000 pounds. The engines have large bearings and wearing surfaces. The boiler is of carbon steel, the driving-wheels of cast steel, the axles of Cambria steel, treated by Coffin process, Krupp steel tires, Nathan sight feed lubricators, Ashton safety valves and mufflers, Jerome metallic packing, French springs, Star steam gages, American driver brakes, Sargent driver brake shoes, Monitor injectors, Baraboor bell-ringers, Mason reducing valves, Marden brakebeams and Westinghouse brakes on tenders.

Personals.

Mr. L. A. Riley has been elected President of the Lehigh & Lackawanna Railroad.

Mr. Leon Hart has resigned as Receiver of the Texas, Sabine Valley & Northwestern.

Mr. K. H. Bates has been elected President of the Kansas City, Oklahoma & Southwestern.

Mr. J. T. Atwood has been appointed Chief Engineer of the Pittsburgh & Lake Erie Railroad.

Mr. Hugh J. Fitch has been appointed Receiver of the St. Louis Avoyelles & Southwestern Railway.

C. C. Crooke, President of the Altamont & Manchester Railroad, died at Stanford, Ky., on July 9.

Mr. S. T. Prince, of Mobile, has been appointed Receiver for the Seaboard Railway Company of Alabama.

Mr. Sidney Emerson has been appointed Chief Engineer of the Wabash, with headquarters at St. Louis, Mo.

Mr. T. H. Perry has been made Purchasing Agent of the Cleveland, Akron & Columbus, with office at Indianapolis.

Mr. B. E. Taylor is appointed Purchasing Agent of the Louisville, New Albany & Chicago, vice J. H. Craig, resigned.

Mr. William J. Dale, Jr., has been reappointed a State Railroad Commissioner of Massachusetts for three years from July 1.

Mr. Chas. H. Grundy has been appointed General Manager of the Marshfield & Southeastern, with office at Marshfield, Wis.

Mr. W. H. Smith is appointed Purchasing Agent for the Atlantic & Pacific Railroad, with headquarters at Albuquerque, N. Mex.

Mr. George W. Kenny is appointed Superintendent of Motive Power of the Rutland Railroad, with headquarters at Rutland, Vt.

Mr. A. McLean has been appointed Superintendent of Motive Power and Equipment of the Georgia Northern, with headquarters at Piddock, Ga.

Mr. Joel H. De Victor has been chosen Vice-President of the Eagle Mere Railroad, with headquarters at Philadelphia, Pa., vice Mr. John R. T. Ryan.

Mr. Joseph McWilliams has resigned as General Superintendent of the Texas Central to accept the position of General Manager of the Marietta & North Georgia.

Mr. William Youngquist, for more than 25 years Foreman of the Chicago, Burlington & Quincy Car Department, died at Creston, Ia., on June 22, aged 54 years.

Mr. W. J. Lewis has been appointed Purchasing Agent of the Peoria, Decatur & Evansville Railway, with headquarters at Evansville, vice H. W. Matters, resigned.

Mr. S. B. Fisher, formerly Assistant Chief Engineer, has been promoted to the position of Chief Engineer of the Missouri, Kansas & Texas, with office at St. Louis, Mo.

Mr. John H. Winder, President of the Seaboard Air Line Belt Railroad at Atlanta, Ga., has resigned, and Mr. R. C. Hoffman, of Baltimore, has been chosen to succeed him.

Receiver and General Manager C. W. Smith, of the Atlantic & Pacific, has removed his headquarters from Albuquerque, N. Mex., to the Great Northern building, Chicago.

General Manager J. H. Macleary, of the Suffolk and Carolina Railway, has resigned and General Superintendent Geo. L. Barton will for the present perform the duties of the office.

Mr. W. F. R. Mills has been appointed General Superintendent and Purchasing Agent of the Denver, Lakewood & Golden, vice J. B. McCormic, previously General Superintendent.

Mr. O. O. Winter, Superintendent of the Willmar Division of the Great Northern, has resigned to become General Manager of the Brainerd & Northern road, a lumber line in Minnesota.

Superintendent Conklin, of the Buffalo, Attica & Arcade, has resigned. Samuel T. Dyke is acting as Master Mechanic, and has entire charge of the roadbed, construction and rolling stock.

Mr. Sanford Keeler, recently General Manager of the Saginaw, Tuscola & Huron road, in Michigan, has been appointed General Manager of the Interurban Electric Railroad, at Saginaw, Mich.

On July 1 Mr. J. Gibbons retired as Chief Engineer of the Vandalia, and his duties devolved upon Mr. F. T. Hatch, in connection with his duties as Superintendent of the Michigan Division.

Mr. Henry G. Morse has accepted the presidency of the Harlan & Hollingsworth Company, ship and car builders, succeeding Mr. W. Taylor Gause, resigned. Mr. Morse was formerly President of the Edge Moor Bridge Works.

Mr. Joseph H. Green, Master Mechanic of the Southern Railway of Columbia, S. C., has resigned to accept the position of Superintendent of Motive Power and machinery of the South Carolina & Georgia Railroad, with headquarters at Charleston, S. C.

Mr. William Berdan, Secretary and Treasurer of the Cooke Locomotive and Machine Company, of Paterson, N. J., has resigned to become Secretary of the National Association of Locomotive Builders, with offices at 26 Cortlandt street, New York City.

Mr. Horace G. Burt, General Manager of the Fremont, Elkhorn & Missouri Valley, will succeed Mr. E. W. Winter as General Manager of the Chicago, St. Paul, Minneapolis & Omaha. Mr. Burt was formerly Chief Engineer of the Chicago & Northwestern Railway.

Mr. George F. Bidwell, Superintendent of the Ashland Division of the Chicago & Northwestern, has been made General Manager of the Fremont, Elkhorn & Missouri Valley lines, to succeed Mr. Horace G. Burt, who becomes General Manager of the Chicago, St. Paul, Minneapolis & Omaha line.

Mr. John C. Sanborn, Superintendent of the Plymouth Division of the Old Colony road, has been elected General Manager of the Boston Terminal Company, which is to build the new Southern Union Station in Boston. He will make a trip abroad to inspect European railroad passenger stations.

Mr. A. G. Wright has been appointed Division Master Mechanic of the Chicago, St. Paul, Minneapolis & Omaha Railroad, with headquarters at Altoona, Wis. He succeeds Mr. W. E. Amann, who resigned to accept the position of mechanical expert for the Galena Oil Company, on the Southern Pacific system.

Mr. B. F. Yoakum, Third Vice-President and General Manager Gulf Colorado & Santa Fe, has been appointed Vice-President and General Manager of the reorganized St. Louis & San Francisco Railroad. Mr. Yoakum has been with the former road for three years, and was previously for several years General Manager and for some time Receiver of the San Antonio & Aransas Pass Railway.

Mr. Nicholas Monsarrat has resigned as President and General Manager of the Columbus, Sandusky & Hocking. He was appointed Receiver of the road in July, 1895, and when the company was reorganized last November he was chosen President and General Manager. He was formerly President and General Manager of the Cleveland, Akron & Columbus.

Mr. A. L. Studer is appointed Master Mechanic of the Southwest Division of the Chicago, Rock Island & Pacific, in charge of the locomotive and car department, with headquarters at Trenton, Mo., vice Mr. Wm. Gesler, resigned. Mr. J. B. Kilpatrick is appointed Master Mechanic of the West Iowa Division in addition to his other duties as Master Mechanic of the K. & D. M. and D. M. & Ft. D. Division, with headquarters at Valley Junction, Ia.

Mr. H. L. Morrill, who retires from the positions of Vice-President and General Manager of the St. Louis & San Francisco road, was Manager of Construction in the building of the Nickel Plate line, and was also at one time General Manager of the Hoosier Tunnel road. He entered the service of the St. Louis & San Francisco Company June 1, 1886, as General Manager, and in 1887 was also made Vice-President, and has been with the company ever since.

Equipment Notes.

The Baltimore & Ohio will soon order a number of combination cars.

The Delaware, Lackawanna & Western is in the market for 1,200 cars.

The Bangor & Aroostook Railroad is in the market for between 600 and 1,000 freight cars.

The Carlisle Manufacturing Company has secured an order for 250 cars for the Pennsylvania.

The Boston & Albany is reported as being in the market for quite a number of passenger cars.

The Chicago Great Western has ordered a new Pullman dining-car for use on its Chicago division.

The Pennsylvania will build eight engines at its own shops for the Western Pennsylvania Division.

The Philadelphia & Reading road has let a contract for 500 freight cars to the Depew Car Works.

The Southern Car Line, with headquarters at Atlanta, Ga., will shortly build about 2,300 freight cars.

The Cincinnati, Jackson & Mackinaw received last month five new day coaches and three baggage cars.

Specifications are out and bids are asked for by the Swift Company for 100 or more refrigerator cars.

Orders for the construction of five "Class R" locomotives have been received in the Erie shops at Susquehanna, Pa.

The Shippers' Refrigerator Car Company, 105 Royal Insurance Building, Chicago, are asking bids upon 10 refrigerator cars.

The Indiana Tank and Refining Company, Rookery, Chicago, has recently organized to transport oil, is in the market for 50 tank cars.

The Erie order for 20 engines was divided equally between the Cooke Locomotive & Machine Company and the Rogers Locomotive Works.

The rumor that the Grand Trunk was in the market for about 4,000 cars is denied, but later reports are to the effect that cars will be ordered in the fall.

The Georgia & Alabama has contracted with the Richmond Locomotive Works for six new locomotives, four for freight and two for passenger service.

It is reported that Nelson Morris & Company will soon increase the number of refrigerator cars ordered from the United States Car Company. The present order is for 55 cars.

The Alabama Great Southern Railroad has placed an order for four locomotives with the Richmond Locomotive Works, three being 10-wheel passenger engines and one for switching service.

The Rome, Watertown & Ogdensburg has placed in service a number of new day coaches, each seating 64 passengers. They have Hale & Kilburn seats, and are mounted on Krupp steel wheels.

The St. Charles Car Works have completed three 60-foot postal cars for the St. Louis & Iron Mountain, embodying several improvements suggested by E. J. Peck, General Superintendent of that road.

The Michigan Central Railroad Company is said to have set aside \$200,000, which will be expended in new equipment this fall. This road expects to order 12 or more locomotives and about 900 freight cars.

The Butler & Pittsburgh Railroad will soon, according to a Pittsburgh daily, be in the market for a large number of ore cars and locomotives, the intention being, it is said, to spend about \$4,000,000 on equipment.

The Illinois Central has 800 cars under contract for delivery in July and August. These orders include 300 refrigerators and 500 coal cars. The road is reported to be in the market for 1,800 cars, but the officers have denied the truth of the report.

New Publications.

THE OFFICIAL RAILWAY LIST, 1896. FIFTEENTH ANNUAL EDITION. *A Complete Directory of Railway Officers etc., and Handbook of Useful Information for Railway Men.* Published by the Railway List Company, Chicago. 403 pages. 4 1/2 by 8 1/2 inches.

This yearly visitor comes to us with its usual smiling exterior and roseate with red edges. It is filled from title page to "finis" with names of railroads, people, addresses and advertisements. It is not easy to test the accuracy of the information which it publishes. One of our contemporaries has pointed out some errors which it contains, which leads to the observation that an annual list of this kind of necessity cannot be as accurate and as fully up-to-date as one which is published monthly, like that given in each number of the AMERICAN ENGINEER, CAR BUILDER AND RAILWAY JOURNAL, and which can be corrected 12 times in a year instead of only once. The official list is of a convenient size and form, and is fat with advertising, which denotes prosperity and peace of mind to its proprietors, and the esteem in which the publication is held by its patrons.

THE RAILWAY AGE AND NORTHWESTERN RAILROADER, Chicago. With its issue of July 3d this well-known journal, following the example set by the AMERICAN ENGINEER, CAR BUILDER AND RAILROAD JOURNAL, reduced the size of its pages to 9 inches by 12 inches, and, as a result, it now comes before its readers in an exceedingly neat dress. Its management is to be congratulated for its enterprise in adopting the new form, and the readers of the paper will undoubtedly appreciate the change.

THE ENGINEERING INDEX, VOL. II., 1892-1895. Edited by J. B. Johnson. C. E. Published by the Engineering Magazine, New York. 474 pages. 6 1/2 by 9 1/2 inches. Price \$4.

The material composing this volume has appeared in the monthly numbers of the *Journal of the Association of Engineering Societies* during the past four years. The first volume was published by the managers of the *Journal* and covered seven years immediately preceding 1892. The present volume is published by and at the expense of the *Engineering Magazine*. This enterprising publication has for some time past been conducting an excellent index to engineering literature and it so completely covered the field that the management of the *Journal* has discontinued its index. To those of our readers who are familiar with the index as it has appeared in our contemporary from month to month, no words of commendation are necessary. To others we would say that we believe it is compiled on the only satisfactory basis for such a work, in that it indexes only such articles as appear to have a permanent value and in a few words outlines the contents of each, so that the reader can judge

for himself whether an article is of the character he is seeking. An index which omits to give any indication of the scope or value of its articles falls short of what is required, and one in which nearly everything is indexed becomes too voluminous. But when a selection is made from the great mass of current literature it must be done wisely, and the fact that in this case the selection has been performed by technical experts is a guarantee that is well done. Hereafter, the volumes of the Engineering Index will appear annually, and we are sure they will be welcomed by all who realize that between the covers of these books, if anywhere, there is to be found a complete index of all important articles on any engineering subject they may desire to investigate. We may, each for himself, save clippings or index articles bearing on our own special lines of work, but we don't cover the whole field, and when one seeks information outside of his specialties, he is very much at sea without such an index.

"NEW YORK AS A SUMMER RESORT;" No. 19 of the "Four Track Series."

This is the title of a neat and attractive little book just issued by the Passenger Department of the New York Central road. It has nearly 100 pages, and is 4 inches by 8 inches in size. It contains much valuable information about the city's hotels, restaurants, theaters, museums, parks, excursion resorts, roof gardens, bathing beaches, fishing grounds, bicycle roads, etc. Its pages are illustrated with many fine engravings, and nothing of interest about the city has been omitted. A brief study of the book is sufficient to convince one that there is much in New York to entertain and interest the summer visitor. A copy of "New York as a Summer Resort" will be sent free, postpaid, to any address on receipt of two 2-cent stamps by George H. Daniels, General Passenger Agent, Grand Central Station, New York.

Books Received.

NINTH ANNUAL REPORT OF THE INTERSTATE COMMERCE COMMISSION, 1895. The Government Printing Office, Washington, D. C. 301 pages, 6 inches by 9 inches.

ANNUAL REPORT OF THE MASSACHUSETTS STATE BOARD OF ARBITRATION AND CONCILIATION FOR 1895. 187 pages, 6 inches by 9 inches.

TWENTY-SEVENTH ANNUAL REPORT OF THE BOARD OF RAILROAD COMMISSIONERS OF MASSACHUSETTS, including railroad returns for the year 1895. 1082 pages, 6 inches by 9 inches.

ANNUAL REPORT OF THE CHIEF OF ENGINEERS, UNITED STATES ARMY, 1895. Government Printing Office, Washington. Seven volumes.

Speed Control of Modern Steamers.

Under the above title Lieut. M. L. Wood, U. S. N., has presented to the United States Naval Institute an interesting paper, suggesting a practical method of directly controlling the engines of steamers from the bridge. After reviewing the practice and improvements in engine-room signals, he proceeds to describe the proposed methods, from which we take the following:

The question naturally comes up, Why is it not practicable to connect the engine telegraph, or a modified form of it, suitable to the new conditions, directly to the mechanism controlling the direction of motion with the speed of the engine, so as to work the engines directly from the pilot-house instead of from the engine-room platform?

It is the object of this paper to show that such a connection is practicable, that it can be made reliable and that it is advisable, on the score of efficiency, by eliminating chances of error in transmitted signals, with increased rapidity in working engines, while preventing damage to engines and lessening the chance of accidents, by allowing constant general inspection while under way by those now stationed to work engines by hand in obedience to signals.

The following is the plan proposed for adoption without interfering with working the engines exactly as at present, when so desired. When the principle is once adopted simplifications can easily be arranged, lessening the number of parts to suit the size of vessel and the different types of engines.

1st. Connect the engine-room telegraph, modified to suit the work, or a special connection designed for the purpose, to a small pinion or suitable gearing, which will move the valve of a small commercial steam steering engine the full extent of its throw, by

the movement of the lever in the pilot-house, the motion being so adjusted that the "stop" position of the lever agrees with the position of the valve for "helm amidships." For convenience, call this small steam steering engine the "regulator engine." The pattern is immaterial, only the valve must be specially designed to move with as slight friction as possible, owing to the small travel of the lever.

2d. In place of the drum on the regular engine, fit a shaft, which, by worm and gear or rack and pinion movement, will move a frame sliding in horizontal guides, exactly as the tiller end is moved by a steam steering engine—the middle part of the travel of the frame corresponding with the "stop" position of the lever in the pilot-house and with the "amidships" position of the valve of the steam steering engine used for the regulator engine.

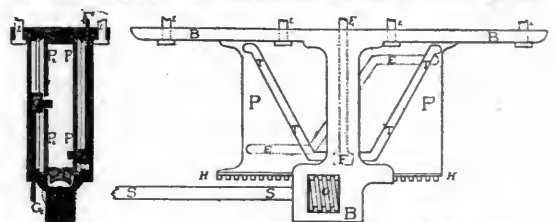
3d. To the frame, called for convenience the "regulator," attach two vertical stiff plates. One of these plates has guide pieces riveted on, or a slot cut, in which a cam, moving in vertical guides, slides. This cam is connected with the valve of the ordinary reversing engine governing its motion. The other plate is connected in precisely the same manner with the main throttle valve. The motion of both cams is controlled by the shape of the slots in which they work, thus regulating the position of the valve of the reversing engine and also the position of the throttle. For every position of the "regulator" there is but one position of the throttle valve and one position of the reversing engine; also these positions will be exactly those required for the most efficient working of the particular engine.

During the middle third of the travel of the "regulator," the direction of motion of the engine is controlled; the outer parts of the travel regulate the speed from "slow" to "full speed" with any degree of nicety required.

4th. Arrange simple accessible means for throwing the automatic engine control apparatus out of action on the shortest notice, allowing the engine to be worked by hand as at present.

There is one mechanical difficulty that interferes with this plan at present. The plan proposed for using these engines as regulator engines will require an easier movement of the valve than is usual with commercial steam steering engine valves. Manufacturers will be able to produce easy moving valves when once in demand; the more readily that as the regulator engine in this plan has to move only two light valves instead of a heavy rudder, subjected to violent jerks, a very small, lightly made steam steering engine will handle the engines of the largest battleship.

Let it be assumed that the motion of the pilot-house lever of the ordinary form of engine telegraph through an arc of 90 degrees will give a motion of six inches, the whole travel, to the valve of a small "regulator" engine in the engine-room. Then it necessarily follows that the sliding frame or regulator can be made to follow the mo-



Regulator for Controlling Engines from Bridge.

tions of this valve exactly, by means that are thoroughly tested and reliable. Suppose the drum of the steam steering engine be attached to the shaft shown in *SS*, Fig. 1, which, by means of the worm wheel, *O*, and the cogs, *H H*, gives a rectilinear motion of say 3 feet to the plates, *P P* and *P₂ P₂*, sliding in bracket, *B B*, Figs. 1 and 2. The movements of the rod, *F₂*, connecting with the throttle, are governed by the guiding slot, *T T*, and cam, *F*, Figs. 1 and 2. The movements of the rod, *G₂*, connecting with the valve of the reversing engine, or, preferably, directly to the links of the main engine, are governed by the guiding slot, *E E*, and the cam, *G*, Figs. 1 and 2, in the plate *P₂ P₂*, Fig. 2.

(Two separate guide slot plates are shown to bring out principle.)

The figures show the regulator in mid-position with the steam shut off and the links half up. The shape of the slots and their relation to each other would be determined by the particular type of engine, but would be designed for the most efficient and safest handling. The location of the regulator engine would be such as to allow the shortest and simplest connections with the engine-room telegraph. It could be under the engine-

room floor or where least in the way. The location of the sliding frame would be close to the engines, where least in the way, against a bracket shelf on a bulkhead, under the engine-room floor, or overhead—the location, except for convenience, being immaterial. The motions from the cams to the reversing engine and the throttle are communicated by bell-cranks or other suitable connections.

The auxiliary machinery, such as circulating and air pumps, can be controlled with but little trouble by additional slots and cams. In fact, all routine movements now performed by hand successfully can be arranged to take place at the exact time required for efficient working without the possibility of mistakes.

No provision is made for the sending of any return signal to the bridge while working automatically, as the motion of the engine will show on the "engine indicators" in the pilot-house, and will be the best and surest indication that can be devised.

In case it be assumed that the engine telegraph cannot be made strong enough, or the friction of the valve with its resistance reduced sufficiently, the valve on the regulator engine can be made to move by a lever of sufficient power, connected with the valve by means similar to, but lighter and simpler than, the connections to the steering engine in the steering-engine compartment.

The primary object of the automatic working of the main engines directly from the dock is increased efficiency. Time will be saved by its use, as well as the elimination of the chance of accident from misunderstanding or faulty execution of signals. Such mistakes have happened with the best men at the throttle, and may happen again. The power of working the engines at all times may be of vital importance. A small piece of a projectile during battle might cut even a small auxiliary pipe filled with live steam, which might make an engine-room uninhabitable before steam could be shut off. The destruction of the draught might fill the compartment with poisonous gases. During the time the engine-room was thus cleared of living beings, might occur a critical moment when the safety or destruction of the vessel would depend on the handling of the engines promptly. The plan proposed would allow the engines to be controlled the same under such conditions as at any other time.

In a vessel dependent on the motion of the engines for propulsion, the importance of the proper working of the machinery at all times, but especially in action or in times of danger, cannot be overestimated. A collision or a torpedo explosion might result in such danger to those below decks that the engine-room would be cleared on account of the possibility of going down with the ship. Control of the engines from the deck would prevent the loss of life due to the vessel sinking while going through the water, or carrying down those remaining at the post of duty in the engine-room.

Various changes will suggest themselves to experts looking over the details of the plan here proposed for speed control. The details as given may appear cumbersome, as the one idea has been to make the principle clear, and this could be done only by sacrificing small details to bring out the general effect. Keeping the reversing engine available for use when desired has also added unnecessary parts. When once the principle is adopted there will be time and opportunity for introducing improvements in many directions to save room and get rid of useless parts.

The following are some of the advantages which would attend the adoption of automatic control of engines:

- 1st. Avoidance of error and accidents due to misunderstanding or poor execution of signals from deck.
- 2d. Quicker working of the main engines, since the motion of one lever on the bridge acts directly on both the reversing engine and the throttle. The engine will be worked in the same time it now takes to make the signal.
- 3d. Complete control of the engines while steam is in the boilers, in case an accident to a steam-pipe or the draught makes the engine-room untenable, or a serious incident, such as being rammed or torpedoed, forces those in the engine-room to leave their post.
- 4th. Greater efficiency in handling the engine with increased security from accidents due to imperfections in the machinery or its working, by allowing those now stationed strictly on the engine platform when under way to move freely about the engine-room, inspecting all parts more frequently.
- 5th. Relief from constant strain of those now stationed to watch engine-room telegraph when under way.
- 6th. Adaptability to any form of engine without lessening usefulness of present system of reversing engines by hand.
- 7th. Ready return to existing style of working engine when so desired.
- 8th. Adaptability of present connections of engine telegraph to new system of working engines without any increase in number of parts or the use of untried systems of connection.
- 9th. Exact and delicate adjustments of speed to suit the exigencies of squadron evolutions in close order.

A Water Power and Compressed Air Transmission Plant for the North Star Mining Company, Grass Valley, Cal.*

BY ARTHUR DE WINT FOOTE, M. AM. SOC. C. E.

Upon the prohibition of placer mining by the State of California, the immense canal systems extending over the western slopes of the Sierra Nevada were left without a purpose, and their future existence depended upon a new use for water. Out of this necessity has grown a business of selling water for power and irrigation, retaining the original methods of delivery at the bank of the canal and miner's inch measurement. The price of water is approximately 1 cent per 1,000 gallons, delivered at the canal; its cost for power depends upon the pressure that can be obtained from it. In the case of the North Star plant, it could have been conveyed directly to the mines and have done its work there on different wheels more or less adapted to the varying conditions; but there is a certain convenience and danger in using water in this manner under a high pressure, and, moreover, the mines are on a hill. So it therefore seemed advisable to convey the water directly to the lowest convenient point, obtain the power there, and transmit this power to the places where it was needed.

This brought forward the subject of transmission of power, and electricity was naturally suggested first. Visits to mines in operation and careful study and investigation of electrical appliances for underground work, especially pumping, finally decided the author in favor of compressed air. The latter method, under the conditions, was believed to be most economical of power, least liable to accident and cheapest in first cost. Moreover, almost absolute security against stoppage could be obtained by having a set of boilers on hand ready for firing up in case the water power or air plant gave out, for, by the use of these boilers and opening and shutting a few valves, all the air motors become equally good steam motors; whereas, with electrical transmission an entire set of steam motors would have to be provided to give equal security; or as the air and steam motors are the same, the electrical motors would require just so much extra expense in cost of plant of equal security against stoppage.

The water supply is obtained from the South Yuba Water Company, at a point on their canal about four miles from Grass Valley, Nevada County, Cal. Thence it is conveyed about 2½ miles to the Empire Mining Company's works in a 22-inch riveted iron pipe, built more than 10 years ago. The new conduit is a riveted steel pipe, 20 inches in diameter, joined to the lower end of this old one under a head of 420 feet, and continues 7,070 feet to the power-house, situated at the lowest convenient point on Wolf Creek, just below the town of Grass Valley, where a head of 775 feet, or a static pressure of 335 lbs. per square inch, is obtained. The capacity of this pipe is sufficient to develop 800 to 1,000 horse power.

At the power-house there is a Pelton water wheel, 18 feet 6 inches diameter, running on a 10-inch shaft, to which a duplex compound air compressor is connected directly. The initial cylinders are 18 inches, and the second cylinders are 10 inches in diameter, with a 24-inch stroke. They were designed to run at 110 revolutions per minute, and require 283 horse power from the water wheel.

A six-inch lap-welded pipe conveys the air at 90 pounds pressure from the power-house to the company's Stockbridge shaft on Massachusetts Hill, 800 feet distant and 125 feet higher. Here it is now being used in a 100-horse-power cross-compound Corliss pneumatic hoisting engine, and a 75-horse-power compound pump, beside other pumps, blacksmith forge, drills, etc.

The Pipe Line.—The line of the pipe is quite crooked, both horizontally and vertically. It is laid in a trench four feet deep, dug with plows and scrapers, except where too stony, and the joint holes were dug by hand. The total cost of all the work of burying the pipe, including covering a large portion of it with stone from the mine dumps, and cement masonry wells for the valves and for sustaining the pipes around bends, amounted to approximately \$6,756.27. This was done on company account, after refusing bids, the lowest of which would have amounted to about \$8,500. An aqueduct of cement masonry across Wolf Creek at the power-house is not included in this estimate, but was built on company account, and cost \$1,435.

The Riadon Iron and Locomotive Works of San Francisco manufactured the pipe from the 48 by 66-inch sheets (rolled by the Central Mills of Harrisburg from slabs furnished by the Pennsylvania Steel Company) and laid it complete in lengths of about 25 feet in the

* Abstract of a paper read before the American Society of Civil Engineers, June 25, 1898.

trench under the following schedule, the longitudinal seams being double riveted by hydraulic riveters:

Head in feet.	Length.	No. B. W. G.	Thickness.	Rivets.	Remarks.
420 to 500	2,320 ft.	9	0.148 in.	$\frac{5}{8}$ in.	Cold riveted
500 to 600	2,110 ft. 6 in.	8	0.165 in.	$\frac{5}{8}$ in.	"
600 to 700	1,158 ft.	7	0.180 in.	$\frac{7}{8}$ in.	"
700 to 750	1,204 ft.	6	0.203 in.	$\frac{1}{2}$ in.	Hot riveted
750 to 775	285 ft.	5	0.220 in.	$\frac{1}{2}$ in.	"
Receiver	40 ft.	.....	0.375 in.	$\frac{1}{2}$ in.	"

The pipe was dipped, after being made into lengths, into the usual hot asphaltum mixture and P. & B. paint was used to cover all surfaces not protected by the asphaltum when the pipe was in place.

About 1,000 feet from the lower end a 12-inch branch with a gate is put in for possible future use, and near it is a 20-inch gate. At the lower end of the pipe in the power-house there is another 20-inch gate, below which is a 12-inch branch leading to the Pelton wheel, and adjoining this is the receiver, 2 feet in diameter, on which are the air chambers, charging tube and relief valve. The air chamber is a 10-inch lap-welded tube 18 feet long standing on the receiver, with an 8-inch gate between. The charging tube is similar, but 8 inches in diameter. Both have 2-inch water discharge pipes and gates, and by proper manipulation of the gates and the operation of inlet check valves on top of the tubes, the air chamber may be filled. Ordinarily the charging-tube is filled up to 90 pounds pressure from the air compressor delivery pipe, and then raised by the water pressure. It is found necessary to put in about one-tenth of the volume of the air-chamber every day. Where the air goes is, thus far, a mystery, as no leak has been discovered.

Water Wheel.—The demand for direct action under a head of 775 feet made a large wheel necessary in order to obtain the proper peripheral speed of half the spouting velocity. The manufacturers objected seriously to undertaking anything over 15 feet in diameter; whereas the proper speed of 60 to 70 revolutions for the compressors required a wheel of nearly 30 feet diameter. A compromise was finally made with a wheel of 18 feet 6 inches diameter, and a compressor revolution of 110 per minute, and the Pelton Water-Wheel Company, of San Francisco, built the wheel from a design by Mr. E. S. Cobb. Had the design been prepared sooner, the wheel could have been made 30 feet in diameter equally well. The Pelton Company guaranteed an efficiency of 85 per cent. at full load, and an average of 75 per cent. from half to full load of the theoretical power of the water, and, at the same time, to so govern the wheel that it should not exceed 120 revolutions nor raise the air pressure above 105 pounds per square inch in case of accident to machinery or sudden shutting off of air. The rim is built up of angles and plates riveted together to break joints. It weighs about 6,800 pounds, and is held concentric with the shaft by 12 pairs of radial spokes of $1\frac{1}{2}$ -inch rod iron held by nuts to the cast-iron hub. The driving force, being applied to the rim, is transferred to the hub by four pairs of 2-inch iron rods, so arranged as to form a truss. The wheel is set on a 10-inch shaft, having a disk crank on either end and connected directly to the compressors. The regulator is a floating valve actuated against excessive velocity by the ordinary ball governor and against excessive air pressure by a spring set to move when the air pressure in the delivery pipe exceeds 90 pounds.

Repeated tests which checked very closely give the wheel an efficiency of a trifle over 90 per cent. for one-quarter, one-half, three-quarters and full loads. Between these points it is somewhat less, as the hood coming down over the nozzle tends to deflect the water as well as hold it back, and decreases the efficiency. It seems probable that the long radius of the wheel accounts for the high efficiency.

Compressors.—Mr. E. A. Rix, of San Francisco, who has made a careful study of air compression, designed the compressors, and they were built by the Fulton Engineering and Ship-Building Company of San Francisco. They are made very heavy, to stand the high piston speed required by the conditions of the water power. Had it been known at the time of designing this plant that a wheel could have been made like the one described, a diameter of 30 feet instead of 18 ft. would have been chosen and the piston speed of the compressors reduced accordingly. The compressor cylinders are 18 and 10 inches in diameter and 24 inches stroke.

The most novel feature of these machines is the intercooler. This is made up of 49 soft copper pipes, 1 inch in diameter, 18 feet long, each with a stuffing box at each end connected with manifold castings. The air delivered from the first cylinder into one manifold passes through these pipes to the other manifold, from which it is

taken to the second cylinder. The whole is placed in the wheel pit directly under and in front of the wheel, so that the water dashes all over and through it. The air leaving the first cylinder at a temperature of 200 degrees Fahr., passes through the intercooler and enters the second cylinder at 60 degrees, slightly cooler than when entering the first cylinder. The temperature is again raised to 204 degrees on leaving the second cylinder and passing into the transmission pipe, showing a total rise in temperature of 282 degrees Fahr.

The transmission pipe, conducting the air at 90 to 100 pounds pressure about 800 feet from the compressors to works at the mine, is ordinarily well tubing $5\frac{1}{4}$ inches in diameter inside. At the mine there is the ordinary air receiver and also three 50-horse power boilers set ready for steam, which are used for receivers.

The air is taken from these into the reheaters designed by Mr. Rix and built by the Fulton Company. It requires a little over half a cord of good pine wood each 24 hours to heat about 700 cubic feet of free air per minute to a temperature 350 to 400 degrees Fahr. The heated air passes through pipes covered with magnesia and hair felt to the first cylinder of the hoisting engine, from which it is exhausted back into the upper heater, where its temperature is again brought to 350 degrees, whence it passes to the second cylinder at 30 pounds pressure. From this it is exhausted through a flue to the change house, where it is used for heating and drying clothes. From the first heater also the air for the pump is conveyed some 300 feet down the shaft in a similarly covered pipe. It receives the air at about 275 degrees and exhausts it into the shaft at about 60 degrees, thus giving plenty of pure cool air to the men, without the usual fans or ventilators.

There is a direct-acting donkey pump situated in another shaft 750 feet distant, to which air is carried cold in a 2-inch pipe over the surface. An old hot water heater is used as a reheater for the air, and consumes 12 sticks of pine cord wood per 24 hours.

The hoisting engine is a compound direct-acting Corliss of 100 horse power with cylinders jacketed for hot air, and is calculated to work 3,000 feet down an incline of about 35 degrees.

Efficiencies.—The plain tale is this. There is 304 theoretical horse power in the water used at the power house, the work actually accomplished at the mine amounts to 203 horse power, and the cost of reheating is \$3 per day.

Efficiency of compression and transmission from water wheel to motors, and not including cost of reheating.....	225.32	= 79.5 per cent.
283		
Efficiency of compression and transmission from theoretical power of the water to the motors, and not including cost of reheating.....	225.32	= 74 per cent.
304		
Efficiency from the water wheel to and through the motors, not including reheating.....	202.7	= 71.6 per cent.
283		
Efficiency from the theoretical power of the water, to and through the motors, and not including the cost of reheating.....	202.7	= 66 per cent.
304		
Efficiency of compression and transmission from water wheel to motors, including the cost of reheating expressed in water power.....	225.32	= 73 per cent.
307.66		
Efficiency of compression and transmission from the theoretical power of the water to the motors, including the cost of reheating expressed in water power.....	225.32	= 68.4 per cent.
329		
Efficiency of compression and transmission from the water wheel to and through motors including cost of reheating expressed in water power.....	202.7	= 65.5 per cent.
307.66		
Efficiency of compression and transmission from the theoretical power of water to and through the motors, including cost of reheating expressed in water power.....	202.7	= 61.6 per cent.
329		
Horse power of air at works after reheating.....	225.32	
Horse power delivered to compressors by water wheel ..	283	
Theoretical horse power of water used on the wheel.....	304	
Horse power of work actually done by the motors.....	202.7	
The horse power delivered by the water wheel to the compressor, to which is added the horse power (21.66) which the cost of the wood used in reheating would buy in water.....	307.66 = 283 + 24.66	
The theoretical horse power of the water used on wheel added to the horse power (21.66) which the cost of the wood used in reheating would buy in water.....	329 = 304 + 24.66	

It may be urged that the conditions are particularly favorable to compressed air, as the transmission is short and the power is not needed for tramways or lighting. But were it 20 miles instead of 1,000 feet, it is thought by the author that, taking the whole plant, compressor, transmission pipe and motor, as against generator, transmission wires, transformers and electric motors, the air will prove cheaper in first cost, higher in efficiency, less liable to accident, and less expensive to operate and maintain.

THE MOST ADVANTAGEOUS DIMENSIONS FOR LOCOMOTIVE EXHAUST PIPES AND SMOKESTACKS.*

BY INSPECTOR TROSKE.

(Continued from Page 137.)

We will now compare the full-length waist-shaped stacks with those that have been shortened, so that we will obtain values similar to those brought together above. As an example of the full-length stack, we take one with a diameter of 14.76 inches, an inclination of $\frac{1}{2}$, a nozzle distance of 18.9 inches and one 15.75 inches in diameter, an inclination of $\frac{1}{2}$, nozzle distance 30.71 inches, and shortened 11.81 inches; also one shortened like the above 11.81 inches, but having a diameter of 14.76 inches, an inclination of $\frac{1}{2}$, a nozzle distance of 18.9 inches, and one 15.75 inches in diameter, shortened 17.8 inches, the inclination being $\frac{1}{2}$ and the nozzle distance 24.88 inches. These are grouped in Table XX.

TABLE XX.

Inclina- tion	Inches. $\frac{D}{d} = \frac{18.11}{14.76}$ $\frac{d_1}{d_2} = \frac{15.75}{14.76}$	Inches. Nozzle diam- eters	Full length		Shortened 11.42 inches. Waist diameter = 14.76 inches.	
			Inches.	Inches.	Inches.	Inches.
Inclina- tion	$\frac{D}{d} = \frac{18.11}{14.76}$ $\frac{d_1}{d_2} = \frac{15.75}{14.76}$	Nozzle diam- eters	3.25 4.06	3.15 3.94	Shortened 11.81 inches.	Shortened 17.80 inches.
Inclina- tion	$\frac{D}{d} = \frac{19.49}{14.76}$ $\frac{d_1}{d_2} = \frac{15.75}{14.76}$	Nozzle diam- eters	2.13 2.83	2.11 2.76		

Further examples are also given by the diagrams of Plates III. and IV. as well as by the group of stacks given in Fig. 41.

The preceding values for the vacuums were obtained entirely independently of each other, on the experimental apparatus, and in each group of stacks comparisons are made with equal nozzle diameters. The difference of a few hundredths of an inch can make no real difference in practice. Hence we may draw the following conclusion:

The shape of the foot of the stack is, for about the lower third of the total height of the stack, without any noteworthy influence upon the action of the air, provided that the current of steam with its surrounding mantle of air finds a free entrance into the stack.

It is, therefore, practically speaking, a matter of no importance whether the base of the stack is cylindrical or conical in form, provided only that it is large enough. In this connection, it may be said that in locomotive practice we frequently find a conical stack setting upon a cylindrical base. It is always well, however, to use a slightly wider foot under a conical stack, since, when steam is being raised as well as when the locomotive is running without steam, it creates a slight draught of the products of combustion.

(c.) Condensations Emitted from the Experimental Stacks.

A peculiar phenomenon connected with these experiments with the apparatus was the shower of condensed water blown from the stack and which has already been mentioned in Section II. It started from a certain position of the nozzle. Lower temperature affected the shower somewhat, but in the hottest months of the summer there was but comparatively little difference. The larger the nozzle opening the earlier the phenomenon appeared, that is to say, the shorter the nozzle distance up to the smallest section.

The shower usually began feebly, increased with the decreasing distance of the nozzle and finally degenerated into a perfect down-pour of water. From this it appears that the current of steam assumes the shape of a cone, and in cylindrical or slightly conical stacks it impinges sharply against the sides, and is here partially condensed, and that a portion of the water that is mingled with the jet is also thrown against the sides. This contact gains in force the shorter the nozzle distance and the smaller the upper diameter of the stack, as compared with its total length measured from the nozzle. The greater the flare of the stack the later does the shower begin and the weaker it is, the smallest diameter remaining the same. For example, take a nozzle diameter of 4.74 inches, with a stack having an inclination of $\frac{1}{2}$ and a minimum diameter of 15.75 inches, with a nozzle distance of 3 feet 8.11 inches, and compare it with a stack having an inclination of $\frac{1}{2}$ and a minimum diameter of 29.92 inches. Table XXI. gives the results of such a comparison.

* Paper read before the German Society of Mechanical Engineers, and published in *Glaser's Annalen für Gewerbe und Bauwesen*.

TABLE XXI.

Stack diam- eters, inches	Nozzle locations in inches, at which the discharge of condensation was first observed, for nozzle diameters of									
	3.94 inches.		4.33 inches.		4.74 inches.		5.12 inches.		5.51 inches.	
	Stack of $\frac{1}{2}$ inclination	Stack of $\frac{1}{4}$ inclination	Stack of $\frac{1}{2}$ inclination	Stack of $\frac{1}{4}$ inclination	Stack of $\frac{1}{2}$ inclination	Stack of $\frac{1}{4}$ inclination	Stack of $\frac{1}{2}$ inclination	Stack of $\frac{1}{4}$ inclination	Stack of $\frac{1}{2}$ inclination	Stack of $\frac{1}{4}$ inclination
11.81	18.90	22.62	18.90	22.65	18.90	18.90	18.90	18.90	18.90	18.90
12.80	22.65	29.92	20.47	26.77	18.90	22.65	18.90	20.47	18.90	18.90
13.78	26.77	36.22	25.20	33.07	20.47	26.77	18.90	25.20	18.90	23.62
14.76	33.07	40.94	29.92	39.37	23.62	33.07	18.90	31.50	18.90	28.35
15.75	39.37	47.42	36.22	45.67	29.92	41.11	23.62	42.52	18.90	40.94

Remarks: Cylindrical stacks of from 13.78 inches to 15.75 inches in diameter began to throw water at a nozzle position of 18.9 inches, but when the diameter was increased to 14.76 inches, the first water appeared at 20.47 inches, the nozzle diameter in both cases being 3.94 inches, and at 15.75 inches diameter with nozzles of 3.94 and 4.33 inches diameter water appeared at 22.65 inches for the first and 20.47 inches for the second.

It may be remarked, that, in consequence of faulty observation, the first appearance of water may possibly have occurred earlier here and there, than is indicated in this table.

In these experiments, that position of the nozzle was always recorded at which the first drops of water were thrown in a circle from the mouth of the stack. It was also recognized, that for a given stack, when this began, the diameter was already too small for the size of the nozzle or the nozzle distance was too great.

In order that we may obtain dimensions that are serviceable from Table XXI., we must always keep the nozzle below the point where water appeared, which means that we must choose a nozzle position for a lower efficiency than that given in the table. (The rules given in Section III. on the determination of the nozzle position supply values which underlie the tabulated figures.)

Similar experiments conducted with locomotives show this throwing of water to be only occasional with small stacks, and even then it does not occur in any great quantity. The reason for this is simply that the current of steam is surrounded by an envelope of the hot products of combustion by which it is partially dried and by which the sides of the stack are also heated.

It was further shown that the same stack, which threw quantities of water from the apparatus, was even more strongly inclined to throw sparks from the locomotive. The latter may be taken to be due, in the first place, to the vacuum being too high, but it is also dependent upon the depth of the bed of the fire, the kind of fuel used (whether coarse or fine, smooth or gritty, wet or dry), also the size of the grates and the air passages between the bars; the number, diameter, and length of the tubes, and the running speed, all of which are matters of considerable importance; the reason for which is that because, in general, the faster the speed the weaker the impulse of each exhaust, although they follow each other with greater rapidity, therefore the draft is more even and gentle than where there is a greater interval between the impulses. But according to all observations the ratio existing between the stack and the nozzle exerts an influence of the first order. A stack that is too large relatively to the diameter of the nozzle cannot exceed and may not even equal the vacuum produced by a smaller stack and a larger nozzle.

A larger stack has a further advantage in comparison with a smaller one on account of its efficiency in tending to free the tubes from dirt, for, in raising steam in a locomotive, the products of combustion are more easily passed through it, and while running down long grades without steam with the engine reversed, the injurious sucking of the smokebox gases into the cylinder is greatly modified.

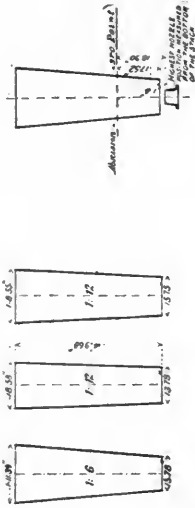
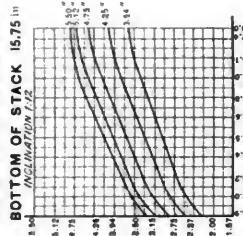
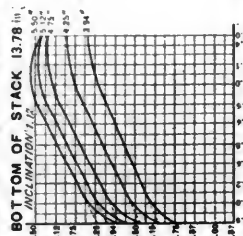
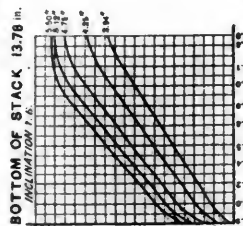
A connection between the water thrown from the apparatus and the sparking on a locomotive seems to lie in the fact that the water throwing was merely a characteristic of the stacks with which the experiments on the apparatus were conducted. If, under practically the same conditions, one stack gives a higher value for the vacuum than another, the first, regarded independently of the absolute size of the stack, is superior to the other from a practical standpoint, if it does not throw water from the apparatus or spark more or less upon the locomotive. From this we conclude that,

The absolute value of the vacuum is not the determining feature in settling the efficiency of the shape of the stack.

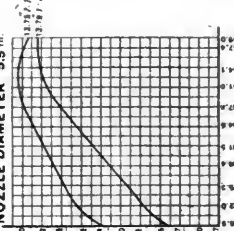
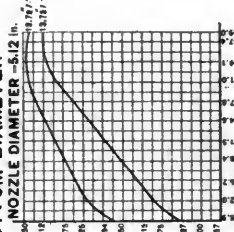
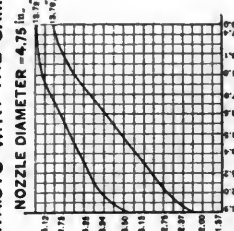
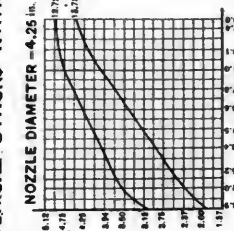
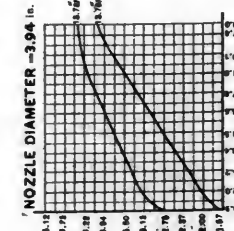
A few examples will assist in making this clearer:

1. As the first fruits of the experimental apparatus were produced we found that, with a nozzle opening of 4.74 inches and a location of 21.65 inches below the bottom of a stack having an inclination of $\frac{1}{2}$, the vacuum produced was superior to that of a stack having an inclination of $\frac{1}{4}$, a fact which was proved on a few

A. CONICAL STACKS WITHOUT WAISTS WITH 5 DIFFERENT NOZZLES



B. CONICAL STACKS WITHOUT WAISTS



C. CONICAL STACKS WITH THE SAME TOP DIAMETER

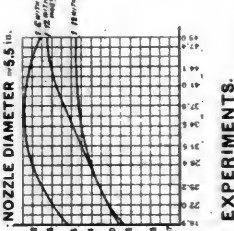
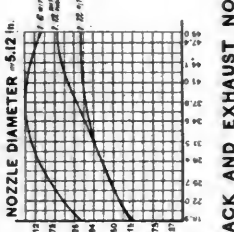
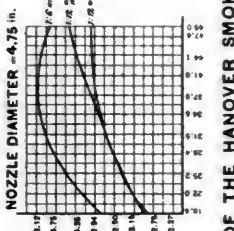
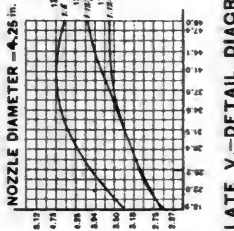
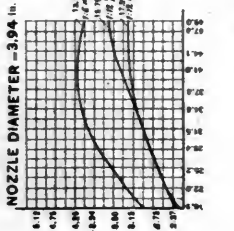
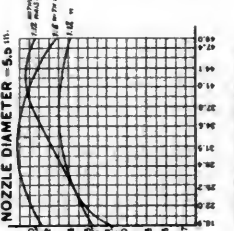
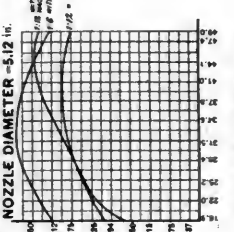
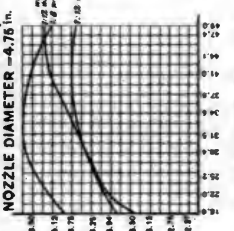
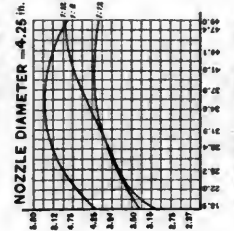
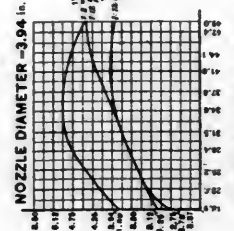


PLATE V.—DETAIL DIAGRAM OF THE HANOVER SMOKE-STACK AND EXHAUST NOZZLE EXPERIMENTS.

NOTE 1.—All observations with the water column were made with the same steam pressure (equal to 5.94 in. of mercury), and with exactly the same air openings.
2.—The abscissa nozzle diameter are taken from a point 17.52 in. above the smallest section and 18.99 in. above the position of the nozzle.
3.—Curves of stacks 15.24 in.—1.12 (with waist) and 17.2 in.—1.12 (with waist), are taken by interpolation from Plate L.

locomotives in service. These had conical stacks, with an inclination of $\frac{1}{2}$, a diameter of 13.78 inches, a nozzle 4.74 inches in diameter, located 19.68 inches below the bottom. A sheet-metal lining with an inclination of $\frac{1}{2}$ was built into this stack of $\frac{1}{2}$ inclination on the locomotive, as shown by the dotted lines of Fig. 45. Then, instead of the efficiency rising, as would have been expected, it not only remained the same, but was accompanied by a few other circumstances. The locomotive exhibited a tendency to throw sparks and, according to the driver, an inclination to eject water as well. In consequence of this the lining was removed and it was decided to substitute for the lining with its $\frac{1}{2}$ inclination a stack of $\frac{1}{2}$ inclination and having a larger bottom diameter. Instead of 13.78 inches it was made 15.36 inches.

In the same way two express locomotives having nozzles 5.51 inches in diameter, located 19.68 inches below the bottom of the stacks which had a diameter of 15.75 inches and an inclination of $\frac{1}{2}$, were fitted with cylindrical linings. Although a higher vacuum was obtained with the cylindrical stack on the apparatus than with stacks of either $\frac{1}{2}$ or $\frac{1}{2}$ inclination, and consequently it would have made a similar showing with those of $\frac{1}{2}$ inclination, the lining was not kept upon either locomotive, since it developed the same peculiarities that the $\frac{1}{2}$ lining had in the stack of 13.78 inches diameter.

The reason for these failures was first shown at a later period, when the connection between the throwing of water on the apparatus and the sparking on the locomotive was discovered. We can now, without any further explanation, and with the aid of Plate II. and Table XXI., see that the stack of 13.78 inches diameter, an inclination of $\frac{1}{2}$, and a nozzle diameter of 4.74 inches, threw water when the nozzle distance was 20.47 inches, while, on the other hand, the one having an inclination of $\frac{1}{2}$ showed its first water at 23.77 inches.

In the same manner the cylindrical stack, 15.75 inches in diameter, threw water with a 5.51 inch nozzle located at 18.9 inches, and at the same point the conical stack, with an inclination of $\frac{1}{2}$, threw water and sparks, so that it is safe to consider that this will begin at shorter nozzle distance with the cylindrical stack, while a stack of $\frac{1}{2}$ inclination (drawing our conclusions from the performance of the one with $\frac{1}{2}$) neither throws water nor sparks at 19 $\frac{1}{2}$ inches. Hence, as we shall see later, it will not do to use a cylindrical stack of the same diameter as the smallest, having an inclination of $\frac{1}{2}$, but it should be somewhat larger, that is about 16.9 inches instead of 15 $\frac{1}{2}$ inches.

2. A few old Erfurt passenger and freight locomotives were in the main shops at Templehof and equipped with stacks like that shown in Fig. 46. These were replaced by others like those shown

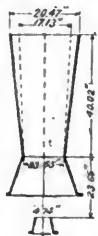


Fig. 45.

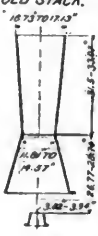


Fig. 46.



Fig. 47.



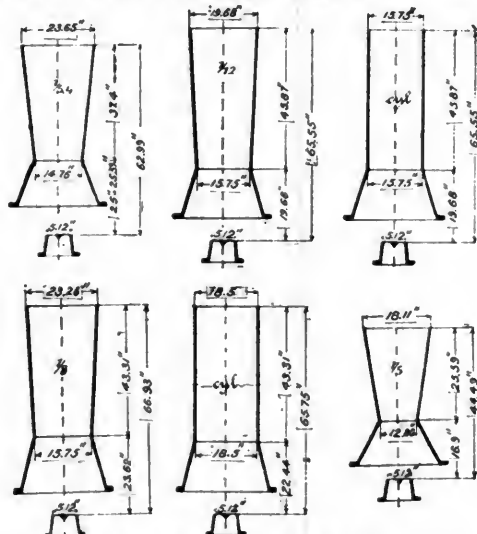
Fig. 48.

in Figs. 47 and 48. The result was that the locomotives with the larger stack and shorter nozzle distance tore their fires very much less and were better steamers than before. Also in a few of these locomotives which had previously shown a tendency to heat the smokebox sheets to red heat, that difficulty was entirely overcome.

Table XXI. shows that the stack 11.81 inches in diameter, and having an inclination of $\frac{1}{2}$ with a nozzle 3.94 inches in diameter, threw water when the nozzle distance was 23.62 inches, and this would be even more likely to occur with the distance of 28.74 inches, as shown in Fig. 46.

3. The stacks of the new Erfurt passenger and fast freight locomotives have the dimensions given in Fig. 49. They are good steamers, and when working easily they throw no sparks, though they probably would with a later cut-off (25 or more). In order that the observations set forth in Table XXI. might be tested by actual locomotive service, five stacks were made in the last-named workshops, that are illustrated by Figs. 50 to 54, and in the winter of 1895 they were applied to two of these locomotives and tested under unfavorable conditions of weather with the same nozzles, which had a diameter of 5.12 inches, with a bridge .31 inches wide

across the opening, thus making it the equivalent of a nozzle 4.94 inches in diameter. With the stack shown in Fig. 50 the locomotive steamed better than before, but it also threw more sparks. The latter feature was true to a still greater extent when they applied the cylindrical stack 15.75 inches in diameter, that is shown in Fig. 51, which was on that account soon removed. The spark throwing diminished very considerably on the application of a waist of the same diameter in connection with a conical portion having an inclination of $\frac{1}{2}$, as shown in Fig. 52, and a cylindrical with a diameter of 18 $\frac{1}{2}$ inches, as seen in Fig. 53.



Stacks of Erfurt Locomotives—Figs. 49 to 52.

The generation of steam with both stacks was also so good that the driver asked to have the experimental stack left upon the engine. Finally with the form illustrated by Fig. 54 the throwing of sparks reached its maximum. It was to have been foreseen that the stack in question should not give the best results, but rather serve as a proof of the assertions made above. On account of the small diameter of the waist it was necessary, according to Plate I., to diminish its length to 25.50 inches with a nozzle distance of 18.9 inches, thus making the total height 44.49 inches, with a very rapid fire, measurements chosen on the basis of Plates II. and III.

Throughout the fourteen days of the test, which was during an unfavorable condition of the weather, the stack caused the engine to steam well, but of all six of the stacks that were tried it threw the greatest quantity of sparks, as we have already said, as well as unburned particles of coal.

A comparison of the curves of this stack as shown in Plate II., in which we bring together and observe stacks with inclinations of $\frac{1}{2}$, $\frac{1}{2}$, and $\frac{1}{2}$, and see that by the application of a bridge to the mouth of the nozzle the water throwing begins with a shorter nozzle distance than that given in Table XXI.; this comparison then gives the following results:

A stack of 14.76 inches diameter, with an inclination of $\frac{1}{2}$, and a nozzle distance of 25 inches, threw no water.

A stack of 15.75 inches diameter, with an inclination of $\frac{1}{2}$, and a nozzle distance of 19.68 inches, threw water.

A stack of 15.75 inches diameter, cylindrical in form, with a nozzle distance of 19.68 inches, threw water.

A stack of 15.75 inches diameter, with an inclination of $\frac{1}{2}$ and a nozzle distance of 23.62 inches, threw no water.

A stack of 18.5 inches diameter, cylindrical in form, and a nozzle distance of 22.44 inches, threw no water.

A stack of 12.8 inches diameter, with an inclination of $\frac{1}{2}$ and a nozzle distance of 18.9 inches, threw water.

The three water-throwing stacks here indicated are the same that upon locomotives in service, threw the most sparks, and which were also the ones that began throwing them the first, while, with the other three stacks, the opposite set of conditions prevailed.

A connection between water-throwing on the apparatus and spark-throwing on the locomotive has, therefore, been demonstrated to exist beyond all peradventure.

(To be Continued.)



Fig. 1.—Perspective View of the Brill Passenger Truck.

A "Perfect" Truck for Passenger Cars.

During the recent conventions, which were held at Saratoga, Messrs. J. G. Brill & Company, of Philadelphia, exhibited a very well made model of a new truck which they are now introducing on steam and electric roads, and which has some novel features, and for which some important advantages are claimed.

Fig. 1 represents a perspective view of one of these trucks, Fig. 2 is a side view, drawn in outline, Fig. 3 a diagrammatic cross-section, and Fig. 4 a view of an elastic swing-hanger, which is one of the peculiar features of the truck.

shown between the two front wheels in Fig. 1. The interior springs are double elliptics, but, of course, spiral springs could be used if it was thought desirable to do so. Two, three or four such springs may be used on each side.

From the description it is obvious that the spring-plank and equalizers can all swing laterally in the stirrups, which form spring swing-links. The load rests primarily on the interior elliptics, or whatever kind of springs are used in that position. It is then transmitted to the spring-hangers, and from them to the journal springs. This gives a very great degree of elasticity to the truck, and enables it to adjust itself with a minimum amount of

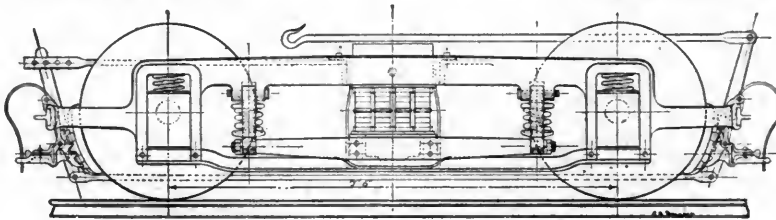


Fig. 2.—Side View of Brill Passenger Truck.

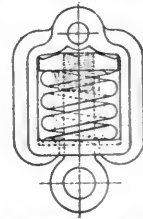


Fig. 4.—Elastic Swing Hanger.

The principle of the construction of the frame resembles that which has so long been adopted for locomotive frames. For steam cars they are forged, and for electric roads they are cast of steel.

The top bar or wheel piece consists of a single bar, which extends from one of the journal boxes to the other, as shown in Figs. 1 and 2. On this bar jaws are forged or cast to receive the journal boxes and on the outermost ones an extension is added to which T-iron end pieces are bolted, which connect the two frames together, and from which the brake beams are suspended. The upper or main bar of the frames have lugs forged on them between the jaws and as near to them as may be practicable. To these the swing links are attached. These are of a somewhat peculiar construction, which is shown clearly in Figs. 1 and 4. They each consist of an open cast-steel stirrup, which receives an eight-inch spiral spring, having a follower nut on top, into which an eyebolt is screwed, the lower end of which is connected to the equalizing lever. The stirrup has an eye in its upper end, by which it is attached by a bolt to the lugs on the wheel piece. The weight which is carried by the equalizer is transmitted to the eyebolt and thence to the spring, which acts as an elastic bearing, at the same time the stirrup can swing laterally on the bolt which passes through its upper end, as indicated on the left side of Fig. 3. The equalizers are made with pivotal ends, which enter the eyes on the lower ends of the stirrups.

The spring-plank consists of two Z-shaped bars, shown by dotted lines in Fig. 2, and filled with wood. These are rigidly fastened to the equalizers, which can swing on the stirrups or links, and the spring-plank moves with it. The transoms consist of angle-iron bars, which are fastened to lugs on the forged frames, but in the cast-steel frames are fastened by angle plates, one of which is

disturbance to the inequalities of the track. The equalizers have also the effect of distributing the load equally on the two wheels on each side of the truck, no matter what the vertical position of any of the wheels may be.

Owing to the fact that the load primarily rests on the equalizers, and by them is transmitted to the main frames at points close to

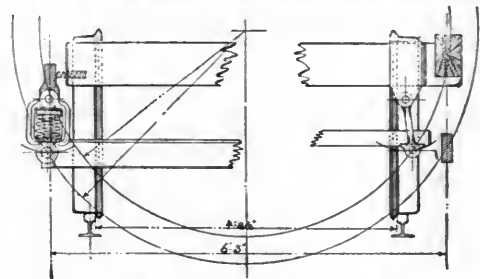


Fig. 3.—Brill Passenger Truck.

the jaws, these frames are subjected to less strains than they would be if the load rested on them about midway between the wheels. The T-iron end pieces and the attachment of the transoms to the wheel pieces or side frames affords a very effective means of holding the truck square.

The result of the lateral and vertical adjustability of these trucks is that they are reported to have great "adherence" to the track

that even on very rough roads they have been found to be safe, and to ride with great ease and comfort to passengers. Messrs. J. G. Brill & Company, the well-known car builders of Philadelphia, are the sponsors for this truck, and are now supplying it for both steam and electric roads.

The Railroad Master Blacksmiths' Association.

The annual meeting of the National Railroad Master Blacksmiths' Association will be held at Chicago, beginning at 10 o'clock, Sept. 1, 1896, at the Tremont House. A specially interesting programme of pertinent topics has been prepared. Arrangements have been made whereby they secure a rate of \$2 per day at the Tremont House, which will be official headquarters. It is located on the corner of Lake and Dearborn streets, Chicago. Members will kindly notify Mr. John Buckley, of the Illinois Central Railroad shops, Chicago Ill., whether they intend to attend the convention, also if they are going to be accompanied by members of their family, and how many. This will give Mr. Buckley an opportunity to make proper arrangements with the manager of the Tremont House.

The Origin of Pneumatic Tires.

In an article in the *Indiarubber World* Hawthorne Hill says: One can readily believe that the attention of visitors to the fashionable parks in London, at a certain period just a half-century ago, was "much attracted" by the appearance among the gay equipages of a certain brougham, after reading the contemporary descriptions of the latter. The vehicle had been constructed without springs, but its chief novelty lay in certain "improvements" patented by a civil engineer of Middlesex County, named Robert William Thomson, in the shape of what he called "noiseless tires." They were, in fact, the pioneer pneumatic tires, and the inventor had boldly started out to exhibit them on the wheels of a brougham weighing nearly 1,200 pounds. The present time marking, as it does, the semi-centennial of so many important applications of indiarubber, seems a proper occasion for recalling Thomson's "patentaerial wheels," though it is not proposed to connect their invention, by any link, with the pneumatic tires which have become so successful.

"The nature of my invention," says Thomson in his specification, No. 10,990 of 1845, "consists in the application of elastic bearings round the tires of wheels of carriages, rendering their motion easier, and diminishing the noise they make while in motion. I prefer employing for the purpose a hollow belt composed of some air-tight or water-tight material, such as caoutchouc or gutta-percha, and inflating it with air, whereby the wheels will in every part of their revolution present a cushion of air to the ground, or rail, or track, on which they run."

This elastic belt, as Thomson called his inner tube, was composed of several thicknesses of canvas, each "saturated and covered on both sides with indiarubber or gutta-percha in a state of solution," laid one upon another, and each "cemented to the one immediately below it by a solution of indiarubber or gutta-percha, or other suitable cement."

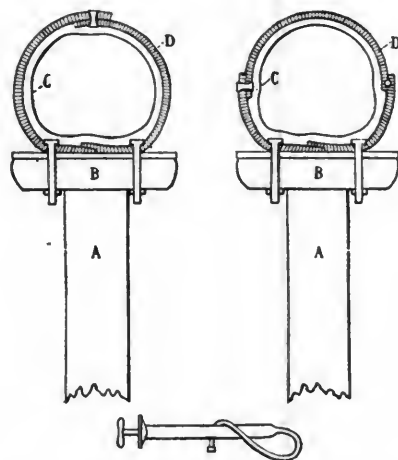
How the edges were joined to complete the belt as a tube is not mentioned.

But it was the outer casing or cover that first caught the public eye, and to understand its construction one must refer to the drawings. *A* represents the end of a spoke; *B* is a section of the wooden felloe, much broader than usual, and tired with steel; *C* is the inner tube, and *D* is the leather shoe. The latter was built upon the wheel by attaching two long strips of leather to the whole circumference, with bolts inserted through the felloe and steel tire at every few inches. The outer edges of these strips were brought together over the inner tube and riveted together, after which the tire was complete.

Or a third strip of leather might be used, as shown in the drawing to the right, being riveted to one of the base pieces and laced to the other. A pipe through which to inflate the inner tube was passed at one place through the tire of the wheel, and fitted with an air-tight screw cap. In the lower drawing is shown the "condenser" used for inflating the tube. It was the size of Thomson's tires, next to the noiselessness of the wheels,

that most attracted attention. They were about 5 inches in diameter, intended to be so inflated as to keep the tire of the wheel 2½ inches from the ground, which was thought to be "sufficient to admit of the wheels passing over any stones or other matters projecting beyond the general level of any ordinary turnpike road without the solid tire coming in contact with them. Wagons for the carriage of goods were expected to need tubes of a larger diameter and stronger materials.

In commenting upon the new-style of wheels, the *Mechanics' Magazine* (London), after the trial brougham had been drawn upward of 1,200 miles, without "the slightest symptoms of deterioration or decay" in the tires, had this to say: "It has so long been regarded as a settled thing that friction is least with hard substances and greatest with soft, that by a natural, though not perhaps strictly logical, course of induction we inferred that, though in this case the noise might be less, the friction, and consequently the tractive power required, would be greater. We must candidly own that we little expected to find the very reverse of this to be the fact. Yet so it is." Then are given the results of experiments made with Thomson's wheels in the Regent's Park by a noted firm of coach-builders, and verified by the editor,



Thomson's Pneumatic Tires.

showing the comparative lightness of draught of the "aerial" wheels, both on a smooth and firm road and on a section covered with newly broken stone.

The table follows, showing draught in pounds:

	Common wheels.	Patent wheels.	Saving by pt. wheels per cent.
Over smooth, hard road.....	45	28	60
Over new broken flints.....	120	38½	301

Evidently our pioneer inventor had given much thought to his work, for in his specification he treated at length of the variations possible in the construction of the pneumatic tire, in order to make the patent as "broad" as possible. Some of it is good reading, too, as showing the ideas he entertained with regard to the properties of air in wheel tires.

One variation of Thomson's original suggestion of an inner tube was that several tubes might be employed for a single tire—up to nine, for instance. In such cases the ordinary air-pipe would have to be dispensed with, the inflation being accomplished by means of air-screws in one end of each tube before they were laced into the leathern envelope. It was suggested that the leather might be protected from wear by covering its outer surface with flat-headed metal rivets secured on the inside with small washers.

The latter end of the "aerial" wheel is not certainly known, but tradition has it that its inventor was much laughed at. Six years after the date of his pneumatic tire patent, Thomson's name appeared in the catalogue of the Great Exhibition of London in connection with an invalid chair, of which "the wheel (in ad-

dition to an iron tire) is shod with a solid band of vulcanized indiarubber, said to be as durable as iron." As late as 1868 all the scientific journals in Europe were describing Thomson's solid indiarubber tires (5 inches thick) for traction engines for common roads.

The Freezing of Gas.

Since gas began to be adopted generally for lighting purposes it has been the aim of gas engineers to prevent the freezing in of gas pipes. Until recently it has been the general opinion that the moisture always present in lighting gas caused the freezing in by its separation in frost-like form, and all the methods known so far to prevent this are based upon the principle of removing the moisture in the gas before its entrance into the conduit pipes. The method formerly employed to reach this purpose was that the gas was exposed in so-called "freezing-out" cylinders to the cold, whereby, of course, the drying of the gas was obtained. But, as in the freezing-out cylinder, not only the moisture contained in the gas, but also large quantities of the light-giving carburated gases were separated, the frozen out gas showed such losses of lighting power that the practical employment of this method was hardly possible.

An extraordinarily simple and cheap method to dry the lighting gas by means of sulphuric acid of certain concentration was patented by the German Continental Gas Company two years ago, and proved quite satisfactory in the beginning. In the last hard winter, however, the chandeliers and conduits froze in again, although the gas entered the distributing pipes entirely free from water, and an investigation showed that the pipes were perfectly stopped up by frost-like formations in the same manner as if undried gas had been used. There was only the difference that these formations did not consist of frozen water, but of frozen, almost chemically pure, benzol.

This discovery shattered at once the former opinion that the freezing in of the pipes was caused by moisture contained in the gas, and the author very soon discovered a method by which not only the freezing of the moisture, but also that of the benzol was made impossible. The principle of this method is, that in the gas works and behind the gas meter, a certain quantity of alcohol vapor is added to the gas. The effect of this alcohol vapor is shown in the fact, that, if, by the action of the cold, separations of water and benzol occur, the alcohol vapor carried along also separates, whereby the freezing point of these separated condensations of water and benzol is forced down so much, that they will not congeal even at our coldest temperature in winter, but remain in liquid condition. They can, therefore, flow back into the main conduit and from there into the next condensing pot. A stopping up of the gas conduit by separation of solid condensations is made impossible in this manner.

The action of the alcohol vapor added to the gas is here an altogether different one of that caused by injecting liquid alcohol into frozen-up pipes. By my method a means is furnished to prevent freezing in altogether, while in the former use of alcohol in the gas works it was but intended to thaw up conduits that were frozen in already.

In the last hard winter it was shown by experiments that the action of the alcohol vapor added at the gas works is still effective at a distance of three miles—that is, the alcohol vapor remains in the gas. The action of the alcohol vapor, however, is stopped as soon as the gas has passed a wet gas meter. In the case of large establishments a small apparatus for evaporating alcohol can be provided behind the gas meter.

For practically carrying out this method a small evaporator of ordinary construction heated by steam, or a little gas flame, is used, into which the alcohol from a higher placed tank flows in a fine, instantly evaporating stream. The hot alcohol vapor is conducted through a little pipe into the gas main and at once absorbed by the gas.

In order to obtain the desired effect about five grammes of 95 per cent. denaturated alcohol must be added per one cubic meter; at very low temperature, about 10 to 20 degrees below zero, this amount must be increased by one or two grammes. In most

cases it is sufficient to commence with evaporating alcohol about half an hour before the street lamps are lit, while the addition of alcohol in the day time would appear to be necessary in exceptional cases only.

This method was employed on a large scale last winter in the gas works at Dessau, where it has given excellent results. Its advantages must not be looked for in the saving of alcohol; on the contrary, in most cases more alcohol is consumed than in the old method, which aimed only at the removal of obstructions produced by freezing it. The great advantages of the new method are found in the saving of wages, and, above all, in the entire removal of interruptions in the distribution of gas, which usually occur when most disagreeable—that is, in the winter, and which are apt to discredit gaslighting during that season.—*Exchange.*

Tests of Boilers.

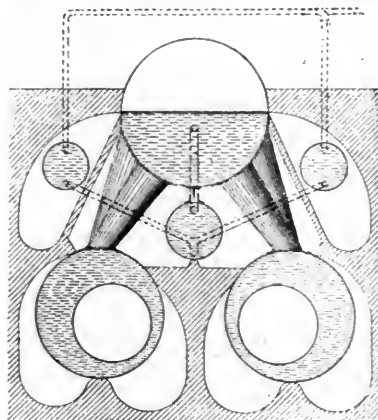
Mr. Lavington E. Fletcher, the Chief Engineer of the Manchester Steam Users' Association, some time ago made some tests of Babcock & Wilcox water tube boilers, from which he draws the following conclusions:

The table shows that the Babcock & Wilcox boilers gave, in the first series of tests, when coal was used, a mean equivalent evaporation from and at 212 degrees, when assisted by an economizer, of 8.74 pounds of water per pound of coal "as used," and 9.29 pounds of water per pound of "dry coal"; and at the second series, when gas coke was used, they gave an equivalent evaporation, when assisted by an exhaust steam feed-water heater, of 9.02 pounds of water per pound of coke "as used," and 10.07 pound of water per pound of dry "coke." These results do not justify the opinion that the Babcock & Wilcox boiler is more economical than the Lancashire boiler.

Mr. Fletcher also made a test of a "Livet Patent Steam Generator."

"This generator consists of three cylinders, one upper and two lower ones, set so as to form a triangle, when regarded either from the front or the back, each lower cylinder having a furnace tube running through it, and being connected to the upper one by a series of conical pipes. (See Figure.)

"In the generator tested by the M. S. U. A., which was a new one, the upper cylinder was 6 feet 6 inches in diameter, and the



Livet Steam Generator.

two lower ones 5 feet 9 inches in the shell, all three cylinders being 24 feet 6 inches long as nearly as may be. Each furnace tube was 3 feet 6 inches in diameter, and fitted with six conical water pipes, while the fire grates were 6 feet long by 3 feet 5 inches wide, giving an area of 41 square feet. In addition to the three cylinders just described, there were three smaller ones placed in the external brickwork flues, two of them being 25

nches in diameter, and the third 30 inches. Through these cylinders the feed water was passed and heated before entering the upper cylinders of the generator.

"The tests were made at atmospheric pressure, all the steam passing away at the manhole, which was wide open."

From the tests it appears that no decided economy attends the use of the Livet patent steam generator, the equivalent evaporation from and at 212 degrees per pound of "dry" coal at tests No. 1 and 2 being 9.66 pounds, which is not superior to that obtained by boilers of the Lancashire type when worked under ordinarily fair conditions.

Further, the Livet steam generator requires a greater width of frontage than the Lancashire boiler. Taking the width from center to center, in a range of Livet steam generators, at 17 feet, and that in a range of Lancashire boilers 8 feet in diameter, at 11 feet, it works out that the Livet steam generator would evaporate 402 pounds (6.4 cubic feet) of water per foot width of frontage, and the Lancashire boiler 622 pounds (0.9 cubic feet). Converting this into power, at the rate of 20 pounds of water per independent horse power, it works out that the Livet steam generator would develop 20 independent horse power per foot width of frontage, and the Lancashire boiler 31 independent horse power, so that a Lancashire boiler develops 50 per cent. more power per given width of frontage than the Livet steam generator.

The M. S. U. A. would decidedly recommend the adoption of a Lancashire boiler, having a length of 30 feet, with a diameter of 8 feet 6 inches in the shell, and 3 feet 6 inches in the furnace tubes, for burning refuse fuel, in preference to a Livet steam generator.

Trade Catalogues.

[In 1891 the Master Car-Builders' Association, for convenience in the filing and preservation of pamphlets, catalogues, specifications, etc., adopted a number of standard sizes. These are given here in order that the size of the publications of this kind, which are noticed under this head, may be compared with the standards, and it may be known whether they conform thereto.

It seems very desirable that all trade catalogues published should conform to the standard sizes adopted by the Master Car-Builders' Association, and therefore in noticing catalogues hereafter it will be stated in brackets whether they are or are not of one of the standard sizes.]

EVAPORATIVE TEST ON THREE STERLING BOILERS AT THE WALTHAM BLEACHING AND DYE WORKS. Waltham, Mass. *Dean & Main and D. P. Jones, Engineers.* Published by the Sterling Company, Chicago, Ill. 8 pages, 5½ by 8½ inches. (Not standard size.)

In this test an evaporation of 13.03 lbs. of water per pound of coal is reported, which, of course is very good and accounts for its publication by the Sterling company.

COMPARATIVE TEST MADE BY THE PITTSBURGH TESTING LABORATORY, LIMITED, FOR CURRIE FURNACE COMPANY. Pittsburgh, Pa. This report is issued by Messrs. H. E. Collins & Co., of Pittsburgh, who apparently are the agents or manufacturers of the Cahall water-tube boiler. The test, of course, showed to the advantage of the Cahall boiler, otherwise, it would not have been published by this firm.

SCHOEN PRESSED STEEL COMPANY, Pittsburgh, Pa. 16 pages, 7½ by 10½. (Not standard size.)

The purpose of this publication is to describe the Schoen Pressed Steel Truck Frame, which is a specialty of manufacture by this company. It is illustrated by outline and perspective views which show all the details of construction very clearly. This truck frame belongs to the class which are made of plate steel flanged and formed into the required shapes, and which are now being very extensively introduced.

AN ILLUSTRATED DESCRIPTION OF A NEW DRIVER KNOWN AS THE LIDGERWOOD RAPID UNLOADER. USED FOR UNLOADING DIRT, BALLAST, ETC., FROM FLAT CARS IN RAILROAD WORKS. *Lidgerwood Manufacturing Company.* New York. 32 pages, 5½ by 9 inches. (Not standard size.)

The title of this pamphlet indicates its character. In it the arrangement for unloading cars is illustrated with a number of half-tone engravings and its construction and operation is described quite fully.

LIDGERWOOD CABLEWAYS, HOISTING AND CONVEYING DEVICES. *Lidgerwood Manufacturing Company.* New York, 110 pages, 5½ by 9 inches.

This is quite an elaborate treatise on the class of machinery which it is intended to describe. With many illustrations and descriptions of the various appliances and their details which are in use. Some illustrations made from photographs of machinery used in the Chicago Drainage Canal are very interesting and give an idea of the magnitude of that great work.

THE JEFFREY LABOR SAVING APPLIANCES. *The Jeffrey Manufacturing Company.* Columbus, Ohio. 54 by 8 inches. 60 pp., (Not standard size.)

The safety appliances referred to in this title are: Chain Belting, Elevators, Conveyors, Carriers, Steel Cable Conveyors, Power Transmission Machinery, Mill, Factory and Mine Supplies and Mining Machinery. Many illustrations of such "plants" are given in the book most of which are half-tone engravings made from photograph, although some of the details are shown by wood engravings. The whole "get-up" is very neat and effective.

INTRODUCING THE STRATT N COMBINED SEPARATOR AND STEAM RECEIVER. *The Goubert Manufacturing Company, New York.* 8 pp. 6 by 9 inches. (Standard size.)

The first word of the title of this pamphlet indicates that it was published for some special purpose, and not as a complete description of the device to which it refers. It opens with an excellent description of what the Stratton Separator is, and then describes the fall of pressure which occurs between the boiler and the engine, and how it is obviated by placing a receiver between them. The purpose of the pamphlet apparently is to show how the appliance described serves the purpose of both a separator of moisture from the steam and a receiver. For a description of the device the reader is referred to a treatise on "Dry Steam the Foundation of Economy," which has been issued by the company.

The illustrations, printing and paper are all excellent.

THE "THORNYCROFT" WATER-TUBE BOILERS. *Messrs. John Platt & Co., Agents.* New York. 8 pages, 7½ by 9½ inches.

Messrs. Platt are the agents in this country for the Thornycroft boiler, which is better known in Europe than it is here. There it has been applied to a great many ships; more than 200,000 horse power are said to be in use. In the pamphlet its advantages are set forth very concisely, and illustrations are given showing the different types and describing their uses.

Another four-page pamphlet of nearly the same size is sent with the first one, in which the Thornycroft automatic field regulator is illustrated and explained. This is an important adjunct to water-tube boilers, and seems to be essential to their satisfactory working.

CATALOGUE OF THE CLEVELAND TWIST DRILL COMPANY, Manufacturers of Increase Twist Drills, Self-Feeding Reamers, Taps, Cutters, etc. 1896. 62 pages, 6 by 9 inches. (Standard size.)

As the name of this company indicates, one of its leading productions is twist drills, and these are found in every conceivable style in this catalogue. The list includes those with straight, taper and square shanks, drills with straight and with spiral flutes, drills with oil-feeding ducts or tubes, drills for machinists' and blacksmiths' drill presses, wood bits for braces and for machines, drills in English measurements and in millimeter sizes, and for many special requirements. The company's grip socket, which embodies a great improvement in the method of driving taper shank drills and other tools, is also illustrated. Boring bars, drill holders, steel sockets for drills, center reamers, nut taps, staybolts and other boiler taps, arborers and mandrels, shell reamers, self-feeding and expansion reamers, chucking and taper reamers of all kinds, end mills and milling cutters, are among the many useful tools illustrated in this catalogue. The company also make twist drill grinding machines of various sizes. Of the goods mentioned many sizes are carried, and the company is also ready to consider the construction of special tools, correspondence concerning which is solicited. The catalogue is very neat in appearance. A copy of it will be sent to any of our readers upon written application to the Cleveland Twist Drill Company, Cleveland, O.

FERRACUTE MACHINE COMPANY. Presses and Dies, Bridgeton, N. J. 32 pages 7 by 10 inches. (Not standard size.)

This catalogue has the peculiarity that all the leaves in it are twice the size of the cover and are folded inside of it, which seems to

be an excellent plan where it is desirable to get a large page and yet keep the size of the book within reasonable limits. The company makes foot and power presses, lathes, bead-ers, dies, etc., for working various kinds of bar and sheet metals, which are very fully illustrated in the catalogue before us.

DESCRIPTIVE CATALOGUE OF THE INSTITUTE FOR HOME STUDY OF ENGINEERING AND OF ELECTRICAL APPARATUS FOR ITS STUDENTS. *The Scientific Machinist Company, Cleveland, O.* 48 pages, 6½ by 10 inches. (Not standard size.)

Competition has invaded the educational institutions as well as other industrial fields. There are now several rival "Home Study" institutions to enable students who cannot attend a school to pursue a course of study at home, and who can be helped in so doing by correspondence with a school which has a staff of instructors. The publication before us gives a description of the methods employed by the Cleveland school, which has been organized as a sort of annex to *The Scientific Machinist*, a paper published in that city. Doubtless many young men who are unable to have any other technical educational advantages may derive much advantage from the system of correspondence which has been organized in this and other schools.

THE ASHTON VALVE COMPANY. Boston. 80 pages. 6 by 9 inches. (Standard size.)

This company manufactures safety valves, steam gages and other kindred appliances and has just issued a new and handsome catalogue. Its frontispiece is a view from a photograph of the works of the company in Boston. Following this is an excellent portrait of the late Mr. Ashton, the founder of the company, whose well-known face was missed at the railroad convention this year, as he had been a constant attendant at these meetings for a great many years.

The illustrations of the articles manufactured by the company are excellent wood engravings and the typography, paper and press work are in excellent taste. The products of the company include the Ashton lock-up pop safety valves for different classes of boilers, water relief valves, shifting relief valves, car-heater valves, mufflers for safety valves, blow-back pop safety valves for locomotives, steam gages and pressure gages for a variety of purposes. Besides these articles the company makes a variety of articles which are collaterally related to the principal departments of its business. The publication ends with a good index, which must be commended.

CATALOGUE AND PRICE LIST OF THE ARMSTRONG MANUFACTURING COMPANY, BRIDGEPORT, CONN.: *Water, Gas and Steam-fitters' Tools and Machines for Cutting Off and Threading Pipe.* 1896. 50 pages, 5 inches by 6½ inches. (Not standard size.)

This catalogue contains descriptions and prices of the well-known Armstrong pipe stocks and adjustable dies in various sizes. The largest of these will thread 4-inch iron pipe. They also make stocks and dies for bolts and for brass pipe. A new feature of this latest catalogue is the pipe threading and cutting-off machines, of which the smaller sizes are made for either hand or power. All the driving gears are enclosed in an oil chamber, which keeps out dirt and chips and insures good lubrication. The largest size will cut off and thread pipe from 1 inch to 6 inches in diameter. The company also makes a full line of vises, including combination, plain and hinged vises, and vise jaws for brass pipes. They also make Armstrong pipe cutters, pipe wrenches, taps and tap wrenches, lathe dogs, machinists' and carriage makers' clamps and many other useful tools. The New York office of the company is at 139 Centre street.

THE STOW MANUFACTURING COMPANY, Inventors and Manufacturers of the Stow Flexible Shaft. Binghamton, N. Y. 40 pages. 6 by 9 inches. (Standard size.)

The Stow flexible shaft is so well known that it is not necessary to give any description of it, but this catalogue contains many interesting pages, illustrating the various uses to which it can be put, and the company manufactures the attachments needed for special work. So general has the use of flexible shafts become that the company has demands for them from nearly all trades and lines of work, including bicycle builders, instrument makers, door and blind manufacturers, surgeons, dentists, etc., etc. To meet special requirements they have been made to run at speed as high as 17,500 revolutions, and there is now quite a demand for

waterproof shafts, which the company has successfully met. Among the many neat devices manufactured by the concern for use with these shafts might be mentioned breast drills, portable drills, pedestal drills, track and "corner" drill presses, tapping and reaming machines, universal joints, countershafts and pulleys for rope drives, portable emery grinders, clutches, spindles, ring grinder, and drill and reamer sockets. They also turn out portable electric motors, fitted with flexible shafts, and their radial flexible drilling machines, which consist of a radial belt drive for the shaft, attached to the ceiling or any suitable overhead structure, will drill a 2-inch hole anywhere within a 21-foot circle without occupying any floor space when not in use.

The company is ready to give its patrons the benefit of its experience in special work and invites consultation where parties have an idea that their wants can be met by any special adaptation of the flexible shaft or its fittings. The catalogue itself is very instructive in this respect and will repay a careful perusal.

DESCRIPTION, METHOD OF OPERATION AND MAINTENANCE OF THE VAUCLAIN SYSTEM OF COMPOUND LOCOMOTIVES. The Baldwin Locomotive Works; Burnham, Williams & Company, Philadelphia: 79 pages; 6 by 9 inches. (Standard size.)

This is a new edition of a pamphlet issued for a similar purpose some years ago, but which has been entirely rewritten, and containing many new engravings of locomotives not heretofore published. It opens with a statement of the aim of the inventor in designing the system of locomotives described therein. The principal features of the compound construction are then described, with an explanation of the action of the steam in the cylinders. To make this clear engravings are given of the cylinders, steam chests, bushings, pistons, valves, diagrams of the valve-gear, valve-stem guide, crosshead, piston, starting-valve and its arrangement. The operation of the engine and the method of running it are next described, and its various advantages are set forth. An interesting diagram is given showing the water consumption of simple and compound locomotives at various points of cut-off. A separate division is devoted to the methods of making repairs of these parts of this type of locomotives, which differ from simple engines. The methods of reboring, renewing and removing the bushings of the steam-chests for the piston-valves—which are used on these engines—is described with illustrations of the apparatus employed and its application to the engines.

In the form of addenda an explanation is given of how fuel economy is effected and the water consumption calculated, and also how the indicator diagrams from the cylinders can be combined to show the action of the steam in the cylinders to best advantage. A list shows that up to date 615 locomotives of this system have been built or ordered of the Baldwin Locomotive Works, which is probably a larger number of compound locomotives than have ever been built by any other establishment in the world. The volume concludes with brief reports of various tests which have been made on different roads with compound and simple locomotives.

Besides the text and various illustrations of details there are 95 engravings of different classes of locomotives illustrated by half-tone engravings made from photographs. These illustrations are of varying degrees of excellence, some being very good and others not so good. Almost all classes of locomotives used in this country and some for foreign lands are included in these illustrations. Among them are tramway motors, locomotives for suburban traffic, for rack mountain roads, single wheel, American and Columbian passenger locomotives, moguls, ten-wheelers, consolidation and decapod engines—all of the Vauc-lain four-cylinder compound construction.

The letterpress is printed in brown ink, but the engravings are black. The paper and topography are excellent, and the volume is bound in a drab-colored paper cover; it may be presumed to indicate its Quaker origin.

MANUAL OF THE SELF-ACTING INJECTOR OF 1887. Wm. Sellers & Co., Incorporated. Philadelphia; 24 pages 6 by 9 inches. (Standard size.)

The title of this catalogue indicates its general character. It illustrates, describes and sets forth the advantages of the form of injector which was brought out by this company in

1887. The illustrations are excellent wood engravings, representing sections and outside views of the different patterns which are made. The opening page gives a "Brief History of the Injector," which is so concise that there is room to quote it entire.

"The injector," it is said, "was invented by Giffard in 1850, and patented by him in France eight years later. In 1860 it was introduced in this country by William Sellers & Co., and the manufacture of it commenced at their works in Philadelphia. The early form of the injector was provided with adjustments for both the water and the steam, and the fact that many of these instruments are still in use attests the advantages of this arrangement. The necessity of frequent adjustment of the water ram led to the invention of the movable combining tube, which automatically regulated the water supply to suit all changes in the pressure of the steam. From this form was developed the Sellers self-adjusting injector of 1876. To simplify the operation of starting and to render the action of the jet positive under the most adverse conditions, automatic starting and a new system of automatic adjustment of the water supply were combined in an injector in which all the nozzles were fixed, the self-acting injector of 1887."

This latter is the instrument described in the catalogue which is before us, the opening page of which gives a statement of "convincing reasons why the self-acting injector of 1887 is better adapted to economical high-pressure locomotive service than any other injector." These "reasons" are followed by a description of its construction and operation. A table of sizes, capacities and prices follows this, after which there is a list of names of parts which are designated by numbers in a sectional view. The following pages give "hints" when the injector will not lift and when it will lift but will not deliver the water into the boiler, and miscellaneous suggestions with reference to the operation and repair of the injectors. In the last part the angle and check valves, which are used with these instruments, are illustrated and described. All the engravings are excellent and are made on wood, and are specimens of the art by which machining may be represented more satisfactorily than by any other now known, notwithstanding all the inventions made in that direction during the last quarter of a century.

ROBINSON RADIAL TRUCK. The Robinson Electric Truck and Supply Company, Boston. 20 pages, 7 by 9½ inches. (Not standard size).

The Robinson Radial Truck, it is said, in the introductory chapter before us, "consists essentially of three flexibly connected single steel axle-frames, each containing one pair of wheels. The end frames are pivotally connected to the car body, while the intermediate frame travels between guides, transversely across the car-body, thereby causing the axles to become radial on curves and parallel on straight lines." This truck belongs to that class in which the frames which carry the end axles are connected to the car body by center pins, about which they can turn. The middle axle—there are three—is attached to the body so that it can move transversely to it. The frames of the end axles are also connected to the middle one in such a way that any transverse movement of the latter will turn the former about their center pins. By this means the three axles are made to assume a position radial to curves.

The pamphlet before us is well illustrated with outline drawings, showing the construction and arrangement of the trucks, and also with half-tone engravings made from photographs of cars with these trucks which have been supplied to various roads in the country.

An appropriation of \$30,000 has been made by the Pennsylvania Railroad Company for a Young Men's Christian Association building at Wall, Pa.

It is reported that American railway corporations contribute \$130,000 annually to the work of local Railroad Young Men's Christian Associations along their lines. Forty-six buildings, whose value is \$560,000, are owned or held by the Railroad Associations for this use.

MASTER CAR BUILDERS' ASSOCIATION.

Abstracts and Summaries of Reports Presented at the Thirtieth Annual Convention.

(Continued from page 164.)

Passenger Car Ends and Platforms.

Committee: E. W. GRIEVES, C. A. SCHROVER, T. A. BISSELL, F. D. ADAMS, M. M. MARTIN, J. J. HENNESSEY, S. PORCHER.

Your committee submits to the Association a drawing of a construction that it considers a combination of the best practices now in use, with some additional improvements in same, for your consideration; but your committee, after careful investigation, has every reason to believe that this construction infringes patents now in use; therefore, it is not in position to recommend that it be adopted as a recommended practice of this Association.

The drawing shows the side sills reinforced ¼ by 7-inch iron plates placed between the side sill and a 2-inch sub sill, and the same thickness of plate placed between the center sill and the 2¼-inch sub sill, each extending back to the tie timber and bolted together in the same manner. The end sill is made 8 by 8 inches, with ¾ by ¾ by 7-inch angle iron placed between the wood and bolted together.

The corners at end and side sills are secured together with ¾ by 7-inch wrought-iron corner bands and ¾-inch bolts. The center sill plate is flanged against end sill and secured in same manner. The end wall framing is reinforced by ½ by 2 by 3¼-inch angle irons, which are flanged to end sill and end plate, and part of the angle iron extending down, connecting the angle irons on the posts to the same on end sill and end plate, making a continuous iron frame on end of car. The vertical tie rods are used in the usual manner to secure the end plate to end sill.

The committee would call attention to the fact that this construction makes a solid iron frame for one end of car, each piece being secured to the other, forming one continuous iron frame. The platform and arrangement of buffer plates, springs, etc., are familiar constructions and are a combination of different platforms now in use, the main feature being that the retaining springs are for the purpose of keeping the buffer and springs in position when not in contact with another car, and the use of the combination malleable iron crosshead guide and buffer spring casting, which abuts against the end sill. Another feature of this platform is the arrangement of draft springs, and the use of cast steel follower carry iron and double pockets, which, in connection with the followers, tail pins and spring pockets, allows the use of two draft springs, thus doubling the capacity of springs without increasing the deflection. The coupler stirrup is also somewhat improved in that it has a very large opening for coupler, which allows sufficient movement to overcome any transverse strains on the platform timbers, the coupler being held in alignment by side springs. The coupler stirrups have enlarged ends and are secured to end sill with two 1-inch rods. The draft timbers and platform timbers are plated with ½-inch iron, which extends the full length of timbers.

The impact required to make a coupling between two cars is exerted only on a small center and two side buffer springs which are calculated to have a capacity of 13,700 pounds, while any other compression after the cars are coupled will go to the buffer springs, having a total capacity of 25,700 pounds. Any compression, when the cars are coupled, would also go on the draft springs through the coupler, and the draft springs would have a capacity of 32,400 pounds, and this, combined with the buffer springs, gives the total buffing spring capacity of 58,100 pounds. The working load of this spring, however, is only about one-half of these figures, or 29,050 pounds. The push-bar is attached to the coupler at the tail pin connecting with cross-head at back of center buffing springs, thus transmitting the draft strains to the buffer springs, keeping the buffers always in contact when cars are coupled together.

Location of Air-Brake Cylinders on Freight Cars.

JAS. MACBETH, RORT. GUNN, H. C. McCARTY, B. HASKELL, F. B. GRIFFITH, A. C. ROBSON, JOEL WEST, Committee.

Your committee finds, on the basis of 1,210,000 freight cars in service at the present time, which is taken from recent reports of the Interstate Commerce Commission, that approximately one-third of this number are now equipped with air-brakes. Experience has demonstrated, at various inspection points, that 55 per cent. of the freight equipment interchanged is equipped with air-brakes at the present time, owing to the fact that a large percentage of cars not equipped with air-brakes do not leave the line of some companies owning the same. This clearly emphasizes the volume of work for the proper maintenance of the brake, and also the additional duties to the inspecting and repairing force. It is therefore apparent that the air-brake cylinders and triple valves should be located in such a position that the attention they require can be readily and safely given, causing the least possible delay to traffic, and result in maintaining the brakes in the most efficient manner. The committee would therefore make the following recommendations:

Air-brake cylinders and reservoirs should be placed on cars on a line inside of stake pocket as near center of car as possible. A clearance of at least 12 inches should be allowed for the removal of cylinder head. Special attention is called to this point, as a number of railroads are now locating cylinder in a position which brings cylinder head within four or five inches from needle beams or other parts of car, preventing, without great difficulty, the removal of head.

The main pipe should be located as near the outside line of side sill as possible. This will enable the men to readily reach and

clean the drain cups in main air pipe, and will also place the pipe in a position on gondola cars, where the least possible injury will be caused by the dripping of water on pipe after having passed through bituminous coal that cars may be loaded with.

The cut-out cock should be located under the car near the center, where it can be reached from either side, and be subject to the least interference by irresponsible parties, which already has developed.

The air brake branch pipe should be connected to top of drain cup in main pipe instead of bottom, in order to avoid, as far as possible, the tendency of dust and dirt to pass through strainer to triple valve.

The release valve should be placed on top of reservoir and handle extended to each side of car.

When necessary to provide holes in needle beam or other parts of car to accommodate rods or levers, the committee recommends that they be made sufficiently large to allow ample space for the operation of rods or levers, as it has already been found that openings provided have been so small as to prevent rods from moving.

Rods should be parallel with line of car, as far as practicable, and properly supported with hangers, to avoid binding and breaking of piston sleeves.

The committee received, after its appointment, a communication from the secretary, stating that it was the desire of the president that it also take up the question of, and incorporate in its report, a method of marking hose, so that the lifetime and service of hose could be more carefully and intelligently followed up.



Proposed Marking of Air Brake Hose.

It is known that some of the leading manufacturers are now marking the hose they manufacture. Their plans were considered, together with additional points that the committee considered essential, in order that the highest uniform degree of efficiency may be reached in hose, and would therefore recommend the marking as shown on accompanying cut.

The number of months' guarantee was omitted, as in the opinion of the committee this is a question between the railroad purchasing and the manufacturer, and by requiring that all hose be plainly marked with the initial of the road purchasing and manufacturer's trade-mark or name, and also a time guarantee, the character and service of the hose can be readily followed up, and such hose, with a very limited time guarantee, will soon develop to the purchaser and manufacturer its inferiority or superiority compared with other hose.

Size of letters and figures to be not less than one-quarter of an inch.

Stenciling of Cars.

A. M. WAITT, S. HIGGINS, H. S. HAYWARD, Committee.

Your committee, to whom was referred the communication from the Car Inspectors' Association of North America, recommending for the facilitating of work of inspection that all car owners be requested to stencil height and width of all high cars on the side of the car, and also that car owners be required to stencil size of journal on truck planks; also the numbers and initials of all box cars on floor timbers between cross-tie timbers, begs to report as follows:

Communication with the Secretary of the Car Inspectors' Association develops that the reasons for requesting the adoption of their recommendations are:

First. To expedite the movement of freight, especially at night, when it is difficult to read the car numbers and initials where they are located high up on car side.

Second. To save loss of time in having to measure unusually large cars in order to know whether they will properly clear bridges, tunnels, etc., on the receiving company's lines.

Third. To facilitate movements of inspectors in ascertaining proper size of journal bearings or axles in connection with repairs.

Your committee wishes to commend the spirit of interest in the improvement of the service shown by the action of the Car Inspectors' Association, and we believe the suggestions made are good ones and worthy of having the general approval of the M. C. B. Association.

There are some difficulties in the way of carrying out literally the proposed stenciling on account of the different contour lines of high cars, and from the fact that some special classes of cars are sheathed over underneath, covering in the sills and floor timbers.

We believe, on the other hand, that the recommendations of the Car Inspectors' Association do not go quite far enough in attaining the desired smoothness in handling inspection work at interchange points. Oftentimes it is impossible for inspectors to tell, in connection with some of the prominent and expensive features of the cars, what is the proper standard. It would seem, to your committee, desirable to a limited extent to cover these points by proper stenciling. Your committee would, therefore, recommend:

First. That on all box cars standing more than twelve (12) feet from top of rail to eaves, the width at eaves be stenciled in 3-inch letters on side of car, as near the bottom as convenient.

Second. That all box, stock and other roofed cars have the number and initials stenciled in 3-inch letters on outer face of outer floor timber between cross-tie timbers, except where cars are ceiled over underneath, in which case the stenciling shall be put on inside face of each cross-tie timber in center.

Third. That all classes of cars have style of coupler and rear attachments, and style of brake-beams stenciled in not less than 1½-

inch letters near one end of car on each side, or on each end of car directly above the buffer blocks where design of car permits it.

Fourth. That where the construction of the truck permits trucks shall be stenciled on each side, giving the size of journal, and the letters "M. C. B." if the axle is M. C. B. standard axle. If the axle is not M. C. B. standard use dimensions from center to center of journal in place of M. C. B. This stenciling to be in 1½-inch letters and to be put on end or side of bolster in Diamond trucks, and on side-truck frame in center on Fox trucks.

Fifth. That on all cars equipped with air-brakes the words "Air Brake," in letters not less than 3 inches high, be stenciled on the sides or ends of the cars, and that the make of air-brake equipment be stenciled (in smaller letters if desired) over or just preceding these words, to enable inspectors to detect repairs made with wrong material. Respectfully submitted,

AMERICAN RAILWAY MASTER MECHANICS' ASSOCIATION.

Abstracts and Summaries of Reports Presented at the Twenty-Ninth Annual Convention.

(Continued from page 157.)

Reciprocating Parts.

Committee, H. D. Gordon, C. F. Thomas, C. G. Turner, T. A. Lawes, J. A. Hill.

The committee making this report assumes that the necessity for keeping down the weight of reciprocating parts is appreciated, and it proceeds at once to discuss various designs for such parts. Under the head of pistons a number of designs are illustrated as follows: London & North Western Railway, single plate cast steel piston, 30 inches diameter, weight 288 pounds; an 18 inch piston, weight 139 pounds; Richmond Locomotive Works, single plate steel piston, 31 inches diameter, weighing 387½ pounds, and complete with rod 535 pounds; a similar 20-inch piston complete with rod 358 pounds; Pennsylvania R. R. single plate steel pistons, one 20 inches diameter, weighing 221 pounds, and one 29 inches diameter, weighing 395 pounds; a steel box piston with castiron bull-ring, built by the Schenectady Locomotive Works, of which one 19 inches in diameter complete with rod, weighs 318 pounds; also a Schenectady single plate cast steel piston of the same size weighing complete with rod, 299 pounds; and the malleable iron piston of the Norfolk & Western Railroad, illustrated in our June issue. In the way of piston rods the report illustrates a hollow rod, 3½ inches, outside diameter, with a 1½-inch hole through it from the front end back to the crosshead fit, which design one member of the association intends to try. Various types of crossheads are illustrated, for four-bar, Laird, and other two-bar guides, some of them reduced to the smallest possible weight consistent with strength. The detailed weight for reciprocating parts for standard engines on the London & North Western Railroad, the Northeastern Railway of England, Lancashire & Yorkshire, and Caledonian Railway of Scotland, conclude the report.

Steam-Pipe Joints.

GEORGE GIBBS, E. A. WILLIAMS, JOHN HIOKEY, J. J. ELLIS, JOHN SMITH, Committee.

As far as the committee has been able to learn it appears to be the uniform modern practice to use cast iron for both steam and exhaust pipes, and this practice appears to give satisfactory results.

Two roads report having made experiments lately with wrought and malleable iron for steam-pipe material. The results are said to be satisfactory, except in the matter of first cost. These pipes are made as thin as consistent with strength and it is claimed they spring so readily that strains on joint-bolts are much relieved and frequency of leaky joints thus lessened.

All but one member state that some form of brass rings are used for top and bottom steam-pipe joints. These rings are sometimes double convex, in others concavo-convex, but most generally plano-convex.

Two members have tried cast-iron joint rings, but condemn them on account of corrosion and the brittleness of the metal, which makes them more difficult to handle. Another member, however, representing a large railway system, prefers cast-iron rings; states they give less trouble than brass, which latter he is replacing as rapidly as possible.

For exhaust-pipe joints, the general custom is to make them with flat surfaces, cast iron to cast iron, scraped to a fit.

Steam-pipe joints are usually secured by two bolts or studs top and bottom, which pass through cast flanges on the pipes, tee-head and saddle. Many of the members who replied to the committee consider this form of joint satisfactory. But others, the majority of whom are using heavy engines in severe service and with high steam pressures, report increasing trouble with loose joints. Their opinion seems to be that more bolts should be used, preferably four top and bottom. The few results obtainable with these reinforced joints seem to indicate that it is the proper solution of the difficulty.

In summing up the information furnished by members, your committee can find little well-grounded complaint with present form of pipe joints in locomotive front ends. And practice is so uniform, even as to details, as to indicate a substantial accord throughout the country in ideas of a satisfactory arrangement. It is quite easy to get the impression, from the ordinary attention to roundhouses which a master mechanic is able to give, that regrinding joints constitutes the chief item of roundhouse repairs, while in reality such work may not be more than would ordinarily be expected from results of service wear and tear.

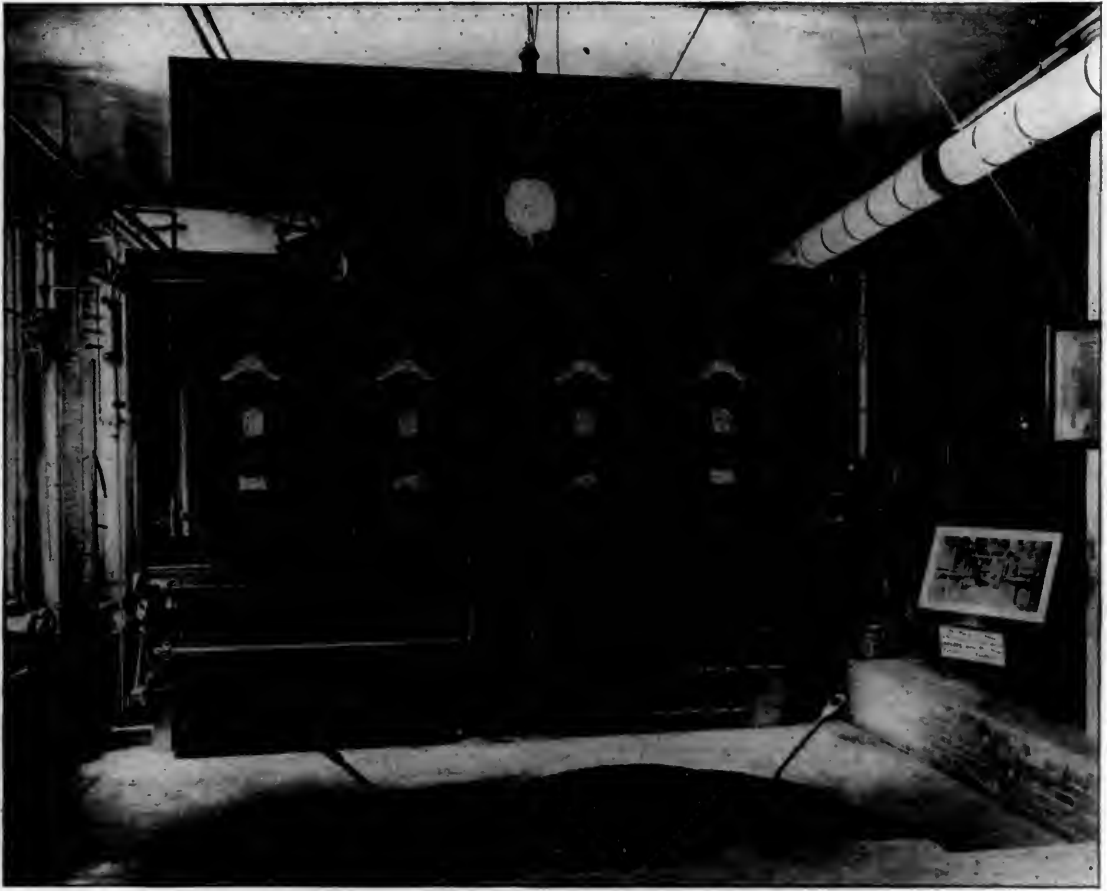


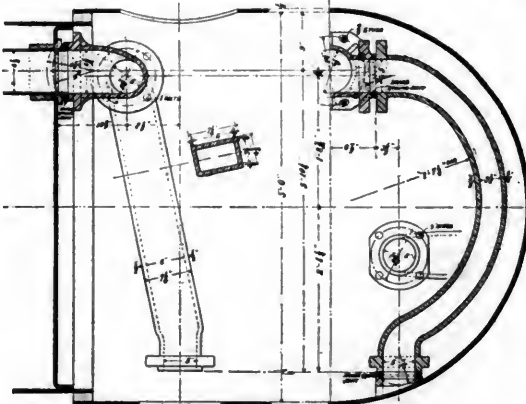
Exhibit of Root's Improved Steam Boiler at the National Electrical Exposition.

It is true that repairing joints is an annoying and lengthy operation with the modern extension front locomotive, laying up the engine for about three days' time, and taking up valuable roundhouse room. The cost of regrinding steam-pipe joints on both ends, at a large division point, may be taken as follows:

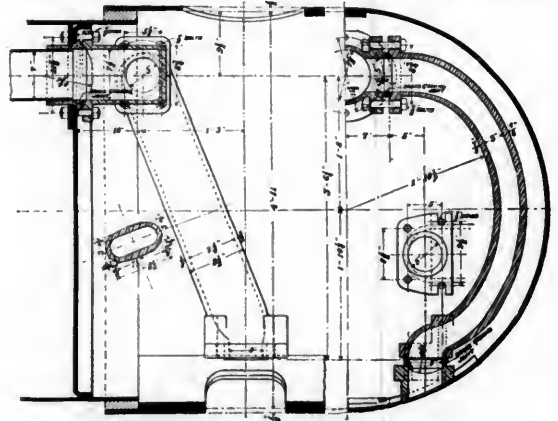
Removing and replacing front end.....	4 hours
" " " steam pipes.....	6 hours
" " " netting.....	4 hours
" " " plates.....	3 hours
Grinding joints.....	10 hours

On all above operations two men are employed, making 54 hours of labor. At rates usually paid machinists, boiler-makers and helpers, the total cost of the operation is about \$10.

In this same large roundhouse, in which 150 engines are turned per day, it was found that between three and four engines per month have pipes reground. Of these, about 40 per cent. had either loose cylinder saddles or had been out of shops after general repairs from two to three months only. In this latter case, the defect was probably caused by some imperfect shop work; and in the former, joints could not be expected to remain tight; in fact, the testimony



Locomotive Steam Pipes.—Fig. 1.



Locomotive Steam Pipes.—Fig. 2.

of members leads to the conclusion that trouble with joints is quite infrequent except on account of bad workmanship, loose saddles or insecure bolting in high pressure heavily worked engines.

The suggestions for improvement made by members follow from the above, and are, briefly, that saddle fastenings be kept tight, and that more bolts be used to hold the pipe flanges together beyond a possibility of their working under the strains caused by expansion.

Your committee would, therefore, offer conclusions in line with the above given evidence, and make the following recommendations for approved practice:

Steam pipes should be of cast iron of flattened section, as light in the body as consistent with strength and the requirements of foundry practice. The shape of the pipes and general arrangement of the joints should be as shown in Figs. 1 and 2.

Your committee suggest, as worthy of trial, pipes of malleable iron or cast steel. Such pipes may be quite thin and still have ample strength, with the resulting advantage of springing instead of working at the joints when expansion strains are brought upon them.

The flanges should be arranged, where possible, to take four bolts or studs at both ends on all heavy engines. These bolts should be equally spaced, if possible. The joints should, in all cases, be made up with plano-convex brass joint-rings, the radii of their convex faces to be about equal to the inside diameters of the rings. These rings should be carefully ground upon their corresponding joint surfaces.

The exhaust-pipe joints should be made with flat surfaces, carefully scraped and fitted with surface plate, and bolted together without copper or other gaskets. A small amount of red lead, or some kind of heat-hardening cement, may be used if preferred.

Figs. 1 and 2 are submitted as representing good practice in the make-up of heavy joints.

Exhibit of the Root Improved Steam Boiler at the National Electrical Exposition.

Our illustration gives a very good view of the exhibit made by Messrs. Abendroth & Root Manufacturing Company, 28 Cliff street, New York, of their well-known improved Root water tube boiler at the recent National Electrical Exposition, New York City.

These boilers were selected by a special committee to furnish all the steam used at the Exposition, the desire being to install a thoroughly reliable and model up-to-date boiler plant.

This was the only working boiler plant shown and attracted much attention and favorable comment from visitors, who could not but be impressed with its cleanliness, efficiency and the ease with which it was managed. There were two equal units, forming one battery of 500 horse-power. A Wilkinson automatic stoker was used to distribute the coal upon the fire.

The evaporative efficiency ranged from 10 to 11 pounds of water to a pound of coal. The C. W. Hunt noiseless conveyor was used in delivering the coal and taking away the ashes.

So safe and simple was the entire operation of this plant that it was put in charge of Mrs. Frank Walton, a licensed woman engineer, who, as chief engineer, managed the exhibit with skill and judgment.

The battery of improved Root boilers used at the National Electrical Exposition was an exact duplicate of the six batteries of Root boilers used at the celebrated tunnel plant of the Baltimore & Ohio Railroad in Baltimore, Md.

Henry F. Hill, 123 Oliver street, Boston, Mass., has been appointed New England agent for the Ingersoll Milling Machine Company.

The Cincinnati, Hamilton & Dayton road is making preparations at its Lima shops for the equipment of all its cars with automatic car couplers.

The Nordberg Manufacturing Company, of Milwaukee, manufacturers of engines, are increasing the capacity of their works, the Niles Tool Company, of Hamilton, O., supplying the new machinery.

Since the Saratoga conventions the Sams coupler has been ordered by seven Eastern railroads, and is being put into service by many companies on special equipment cars and on cars that do not go into interchange traffic.

The contract for the building of the Butler & Pittsburgh Railroad was let last month. There were 47 different bids representing 100 firms all over the country. The contract was given to C. I. McDonald & Company, of Pittsburgh.

The Sargent Company, of Chicago, have made a contract to handle the "Compo" brake shoe in the West. This shoe is a combination of cast-steel and compressed wood, and is meeting with great favor on electric and elevated railroads.

Mr. Otto Goetze, 114 Broad street, New York, has issued a little pamphlet descriptive of "Mannocitin," and containing the opinions

of some leading American firms regarding it. Mannocitin is a rust-preventive which those who have given it a trial find to be most excellent. Any one wishing to obtain a copy of the pamphlet can do so by applying to Mr. Goetze.

The Q & C Company, Chicago, has recently made a valuable addition to its Perfection Oil Purifier, illustrated in our April number. This is a thermostatic temperature regulator, which automatically holds the temperature at a degree which facilitates the filtration of the oil without overheating. Several of these are in operation with very satisfactory results.

The firm of Wilson & McIlwain, manufacturers' agents, at Pittsburgh, has been dissolved by the withdrawal of John T. Wilson, whose other business interests made it impossible to devote the necessary time to the firm's affairs. Mr. McIlwain has associated with him his son, Harry M., and will continue the business under the firm name of J. D. McIlwain & Company.

The Brown Hoisting & Conveying Machine Company, Cleveland, O., have sold to E. D. Smith & Company two standard 10-ton locomotive cranes to be used on the work of extending the wheel pits of the Niagara Falls Power Company, to accommodate seven more 5,000 horse-power turbines. These cranes are fitted with extra large drums to take the great length of rope that will be required in hoisting out of the wheel pits.

To the New York Steam Company's Cortlandt street plant has recently been added a 1,000 horse-power boiler weighing 119,000 pounds, or 50½ tons. The boiler was built by the Edgar Boiler Company, Limited, of Warren, Pa. It is of the vertical tubular cylindrical type, 23 feet long and 10 feet in diameter, with 220 tubes 5 inches in diameter. The shell is of ¾-inch steel. A 7-inch circulating tube surrounds each tube from the water line to near the bottom head.

The Ingersoll-Sergeant Drill Company have received an order from the Pennsylvania lines for four half-duplex air-compressors of the class "G" pattern, with Myer valve gear. The steam cylinders are 10 inches in diameter; air-cylinders 10½ inches in diameter; stroke 12 inches. These compressors will be located as follows: One at Columbus, O.; one at Denison, O.; one at Indianapolis, Ind.; and one on the Vandalia road at Terre Haute. The Big Four has also ordered a similar compressor for its Brightwood shops.

During the month of June Mr. Henry L. Leach, 176 Huron avenue, North Cambridge, Mass., shipped 170 sets of his pneumatic sanding apparatus, 119 of these going to the various locomotive builders for new equipment, as follows: To Baldwin, 25 for Lehigh Valley; to Pittsburgh, 22 for Vandalia and 12 for Seaboard Air Line; to Schenectady, 5 for Southern Pacific, 10 for New York, New Haven & Hartford and 2 for Fitchburg; to Cooke, 5 for Southern Pacific and 10 for Baltimore & Ohio; to Richmond, 25 for Baltimore & Ohio; to Brooks, 3 for Burlington, Cedar Rapids & Northern. Among the shipments for old equipment were 30 for the Norfolk & Western and 12 for Southern Railway.

The Carnegie Steel Company, Limited, nearly two years ago, after making an investigation of the merits of the Cahall vertical water tube boiler, put in a trial plant of these boilers of 2,000 horse-power at their gas pumping plant, at Bagdad, Pa. The performance of the boilers was such a marked improvement over the general boiler practice of to-day that four of these boilers were afterward put in at their Edgar Thomson Steel Works. They have been so well satisfied with the work done by these that they have made arrangements to tear out all the old style boilers at furnaces A, B and C at the Edgar Thomson Steel Works and have purchased 5,250 horse power of the Cahall vertical water tube boilers, to be installed in place of the ones to be removed.

The facilities of the Roberts Safety Water Tube Boiler Company have been so greatly enlarged that they have just completed a 150 horse-power Roberts boiler for the steam yacht Sultana, on an order from the Erie Basin Dry Dock Company, in eight working days from the time they received the order. This boiler is built in the company's best style, the material has all been inspected, and the boiler will pass inspection for 250 pounds of steam. Two weeks' time was allowed by the contract, but the owner was very anxious to have his yacht in commission on July 4th, and the Roberts Boiler Company decided that they would beat the record on boiler building, and have undoubtedly done so. Notwithstanding the lateness of the season, they are running full time and have been working nights and Sundays lately.

The contract for the new bridge, to take the place of the railroad suspension bridge now spanning the Niagara River, has been

awarded to the Pennsylvania Steel Company, Steelton, Pa. The new bridge will have a span of 550 feet between piers, with short spans connecting the main span to the bluffs. It will have two floors, the upper one for two railroad tracks and the lower one for carriages, trolley cars and pedestrians. The piers will be of masonry built on the limestone about half-way up the sides of the bluff. The superstructure will require 2,780 tons of steel plates and angles, 100 tons of steel castings, 91 tons of steel I-beams and pins, and 15 tons of iron rods and turnbuckles. The bridge is designed for a load on the railroad floor of two consolidation engines, with 40,000 pounds on each pair of drivers, followed by a train of 3,500 pound per lineal foot, and at the same time the highway floor is to support a live load of 3,000 pounds per foot.

The Bates Thermic Engine Company, of Philadelphia, has been organized to build engines for furnishing power through the medium of gas. Russell Thayer is President of company, and Allan B. Rorke John F. Betz, Prof. W. D. Marks, Professor Houston, Professor Kennelly, Clement Newbold, D. S. P. Chew, Dr. Filbert, E. C. Quinn, Henry Clay, Jas. McManes, Jas. H. Harper, Clarence L. Harper and others are prominently connected with it. The engine to be built will produce power direct from fuel. It will require from 35 to 40 per cent. less space than ordinary engines, and save 25 per cent. in weight per effective horse power, which in steamers and torpedo boats is an immense advantage. The makers will guarantee a saving of 60 per cent. in the fuel necessitated by the use of the modern engine. Three of these engines are at present in operation in Europe, and five others are in course of construction. The fuel is burned under pressure in a small chamber near the engine cylinder and the gases of combustion used expansively in the cylinder.

The Hazelton Boiler Company, New York City, reports recent sales of boilers, aggregating 2,450 horse power, as follows: The Rochester Gas & Electric Company, Rochester, N. Y., 500 horse power; the Lambertville Rubber Company, Lambertville, N. J., 200 horse power; the Goodyear Rubber Company, Middletown, Conn., 150 horse power; the Bristol Electric Light & Railway Company, Bristol, Conn., 200 horse power; the Equitable Gas Light Company, New York, 500 horse power; the Pettebone-Cataarct Paper Company, Niagara Falls, N. Y., 250 horse power; the North Adams Gas Light Company, North Adams, Mass., 150 horse power; the Canandaigua Electric Light & R. R. Company, Canandaigua, N. Y., 250 horse power, and the Newton Falls Paper Company, Newton Falls, N. Y., 250 horse power. They have also recently completed contracts with the Capewell Horse Nail Company, Hartford, Conn., and Messrs. P. & F. Corbin, New Britain, Conn. The company reports that nearly all of their orders now being received are for the very earliest possible delivery, and that many of their recent sales have been made to old customers who are now enlarging their plants. The original boilers sold to these customers have been in constant operation for from eight to ten years, without repairs, still carrying high pressure, and giving the same fine results as when new. This, together with the fact that the Hazelton Company has made various improvements in the construction and setting of their boilers, increasing their efficiency and economy, and improving their appearance, makes it much easier for them to make sales now than formerly.

The Edward P. Allis Company, of Milwaukee, Wis., are at present very busy. Among the recent orders they have received may be mentioned two cross compound engines of 1,000 horse power each, direct-coupled to electric generators, for the Syracuse Street Railway Company, Syracuse, N. Y.; one engine of 800 horse power for the Brockton Street Railway, Brockton, Mass.; large hoist for Butte, Mont.; four large engines for the Otis Falls Pulp Company, Maine; a cross compound condensing engine for the McCormick Harvester Machine Company, Chicago, and a tandem compound engine for the Sandusky Electric Light Company, Sandusky, O. Their engine department has in hand the order recently received from the Northwestern Elevated Railway Company, of Chicago, for 9,000 horse power of engines, and they have just shipped a vertical compound condensing engine of 2,500 nominal horse power to the Warren Manufacturing Company, Warren, R. I. They have just started a twin tandem compound condensing engine of 2,500 horse power in the new Berkshire Cotton Manufacturing Company mill, Adams, Mass., and the first of the six large pumping engines which they are building for the city of Pittsburgh, in addition to which they have shipped the Canal & Claiborne Street Railway Company, New Orleans, two tandem compound condensing direct-coupled engines of 700 horse power each.

Their mining department has just received an order for the complete machinery of a large new reduction works to be built in

Colorado. This order includes the engine, boilers, crushers, rolls, concentrators, chlorination barrels, etc., etc., in fact the entire machinery of the plant. The company's saw-mill department has had an order placed with them for the complete machinery of a mill in California which will be one of the largest saw-mills in the country. They supply in addition to the saw-mill machinery the necessary engines and boilers. There are now in operation six of the twelve vertical compound condensing blowing engines which the concern is building for the Carnegie Steel Company, and these machines in service more than exceed the expectations of all concerned. They are also about to ship a pumping engine to the city of Sacramento, Cal., and are beginning work on the large pumping engine recently ordered for Cleveland.

Our Directory

OF OFFICIAL CHANGES IN JULY.

We note the following changes of officers since our last issue. Information relative to such changes is solicited.

Altamont & Manchester.—President C. C. Crooke died July 9. *Kansas City, Oklahoma & Southwestern.*—Mr. K. H. Bates has been elected President.

Louisville, New Albany & Chicago.—Mr. B. E. Taylor has been appointed Purchasing Agent, vice J. H. Craig, resigned.

Buffalo, Attica & Arcade.—Mr. S. T. Dyke is acting Master Mechanic in charge of rolling stock and road bed.

Brainerd & Northern.—Mr. O. O. Winter is appointed General Manager.

Boston Terminal.—Mr. J. C. Sanborn has been elected General Manager.

Atlantic & Pacific.—Office of General Manager and Receiver removed to Great Northern Building, Chicago. W. H. Smith is appointed Purchasing Agent, with office at Albuquerque, N. Mex.

Rutland.—Mr. Geo. W. Kenney is appointed Superintendent of Motive Power, with office at Rutland, Vt.

Seaboard Air Line R.R.—Mr. R. C. Hoffman is chosen President to succeed Mr. J. H. Wicker, resigned.

Chicago, St. Paul, Minneapolis & Omaha.—Mr. A. G. Wright has been appointed Division Master Mechanic at Altoona, Wis., to succeed Mr. W. E. Amann, resigned. Mr. H. G. Burt succeeds Mr. E. W. Winter as General Manager.

Wabash.—Mr. Sidney Emerson has been appointed Chief Engineer, with office at St. Louis.

Texas, Sabine Valley & Northwestern.—Receiver L. Hars has resigned.

Georgia Northern.—Mr. A. McLean has been appointed Superintendent of Motive Power, with office at Pidecock, Ga.

Pittsburgh & Lake Erie.—Mr. J. T. Atwood has been appointed Chief Engineer.

Missouri, Kansas & Texas.—Mr. S. B. Fisher has been promoted to be Chief Engineer, with office at St. Louis.

Eagles Mere Railroad.—Joel H. DeVictor has been elected Vice-President, with office at Philadelphia, Pa., vice John R. T. Ryan.

Peoria, Decatur & Evansville Railway.—H. W. Matters having resigned, W. J. Lewis has been appointed Purchasing Agent, with headquarters at Evansville, Ind.

Lehigh & Lackawanna Railroad.—L. A. Riley has been elected President.

Cleveland, Akron & Columbus Railway.—T. H. Perry is Purchasing Agent, with office at Indianapolis, Ind.

California Eastern.—The following is a list of the officers of the new company: President, R. W. Woodbury; Vice-Presidents, D. G. Scofield and W. N. Byers; Treasurer, I. B. Newton, and Secretary, R. S. Selbert.

St. Louis, Avoynes & Southwestern Railway.—Hugh J. Flitch has been appointed Receiver of this company.

Columbus, Sandusky & Hoicking.—Mr. N. Monsarret has resigned the positions of President and General Manager.

Denver, Lakewood & Golden Railroad.—W. F. R. Mills has been appointed General Superintendent and Purchasing Agent, vice J. B. McCormick, previously General Superintendent.

Marshfield & Southeastern Railway.—Charles H. Grundy has been appointed General Manager, with office at Marshfield, Wis., vice A. A. Hopkins. The Chicago offices are removed to No. 508-9 Roanoke Building.

Southern.—Mr. Joaep H. Green, Master Mechanic at Columbia, S. C., has resigned.

South Carolina & Georgia.—Mr. Joseph H. Green has been appointed Superintendent of Motive Power, with office at Charleston, S. C.

Marietta & North Georgia.—Mr. Joseph McWilliams has been appointed General Manager.

St. Louis & San Francisco.—Mr. B. F. Yoakum is General Manager, vice Mr. H. L. Morrill, resigned.

Fremont, Elkhorn & Missouri Valley.—Mr. George F. Bidwell has been made General Manager, vice H. G. Burt, resigned.

Suffolk & Carolina.—General Manager J. H. Macleary has resigned and Superintendent George L. Barton will perform the duties of the office until further notice.

Employment.

Employment wanted by a man of several years' experience as foreman and general workman. In coach and engine painting, can furnish best of reference as to ability and sobriety. Address AMERICAN ENGINEER, CAR BUILDER AND RAILROAD JOURNAL.

AMERICAN ENGINEER CAR BUILDER AND RAILROAD JOURNAL.

SEPTEMBER, 1896.

THE ALTOONA SHOPS OF THE PENNSYLVANIA RAILROAD.

III.

(Continued from page 169.)

The focus of Altoona is the Logan House, a hotel which was built soon after the shops were located there, and which is now in the center of the city on the north side of the railroad tracks, the great locomotive repair shops being on the south side and opposite to the hotel. The hotel is not shown in the plan of the shops, which was published in our June number.

For convenience of reference this plan is reprinted herewith, and the position of the hotel is indicated in the reprint. The erecting shop, No. 1, shown in the plan, is directly opposite to the hotel and first attracts attention. It was, we believe, the first shop of the kind in this country which was built with longitudinal tracks and overhead traveling cranes, and has been the subject of frequent study and much criticism by railroad men ever since it has been erected. The cranes were made in England and are carried in brick arches along the sides of the shop. These are large and cumbersome and exclude a good deal of light, and would not be repeated if the shops had to be rebuilt. In fact it is said that the cranes which were originally put into this shop are now too light for the heavy engines which must be handled, and plans are under consideration to replace the cranes with heavier ones, and substitute an iron supporting structure to carry them.

Erecting shop No. 2 forms a part of the same group of buildings and is similar to No. 1, and has three longitudinal tracks with a pair of overhead travelling cranes which were built in Altoona. They, too, are carried on brick arches, but these are arranged so as to light the shop better than No. 1 is lighted. The two side tracks each have a pit, while the centre one has not. The engines to be repaired are placed on the side tracks, and the middle one, as far as possible is kept clear. The space between the middle and side tracks is excavated and covered over. In these basements, as they may be called, the water and steam pipes for heating the building and testing boilers are located. In the No. 1 shop the pump and accumulator for the water pressure, are located under the floor. The boilers are all tested first by a cold water hydraulic test, and then with hot water and steam pressure. For both tests the water is conducted to the boilers by the system of pipes described, and in making the steam test the boilers are entirely filled with water, which is then heated, and expanded with steam from the steam pipes.

The space below the floor is also used for storing the parts of engines, which are brought in for repairs, and are dismantled. The wooden floor is removable which enables the parts to be easily deposited in the basements and taken out again when they are needed.

There is room for nine engines on each track and about 34 can be repaired and turned out each month in each shop, although the average is not as great as that number. The cranes are not very rapid in their movements and for that reason they are used for handling only the heaviest parts of the locomotives which are being repaired. As has often been explained, any engine can be lifted up bodily and transferred laterally over the middle track, and then moved longitudinally to any point in the shop, and again carried over to either side track and placed wherever it may be required. In this way, if for any reason it is desirable to give precedence to some engine, it can be taken up and placed in any desired position.

These shops and the appliances in them have now been in use for a good many years and although the relative merits of shops with longitudinal and transverse tracks is still a much-disputed question it would be hard to find any one about Altoona who would advocate the building of an erecting shop with transverse tracks and a transfer table, which is the usual plan adopted in this country.

The general arrangement of these shops may be commented on. The machine shop is a two-story building centrally located between the two erecting shops, with which it is connected by wings at the south end. At the north each of the three parallel shops abuts against a transverse building with tracks leading out to a transfer table. In this shop the cylinders, frames, trucks, etc., are assembled, and put together, preliminary to being taken into the erecting shops. Between the machine and erecting shops there are open spaces where wheels, castings, etc., are stored temporarily before being taken into the shop. West of the transfer-table is the wheel shop, smithy and boiler shops. The wheel shop is in a direct line with the machine shop, and all the buildings last referred to are connected with the transfer table and by that means material or partly finished work can be carried to any part of the machine or erecting shops. Still farther north is the wheel foundry and another larger foundry for general castings. The brass foundry and other smaller buildings are distributed as shown in the plan from which it will be seen that what may be called the co-relation of the shops is very convenient and that although the present arrangement of buildings has been the result of a process of evolution it has not been without a system which has evidently been carefully thought out. The location of the three round houses Nos. 1, 2 and 3 is shown and also that of the testing laboratory which is now famous the world over.

At the time of our visit to the erecting shops all the engines in No. 1 it was noticed had Belpair boilers. The Pennsylvania Railroad has adopted this form of boiler more extensively than any other line in this country, and, apparently, have no present intention of abandoning it, but are applying it to all new engines which are built and to old ones which are rebuilt. It is true that some of the earlier boilers of this type, which were too small, have been removed and are now used in stationary service, but the number is constantly being increased and the type is adhered to, which indicates that it has been giving satisfaction. Some

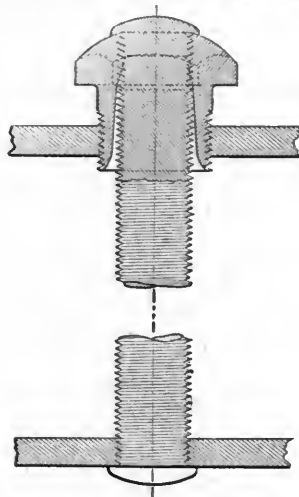
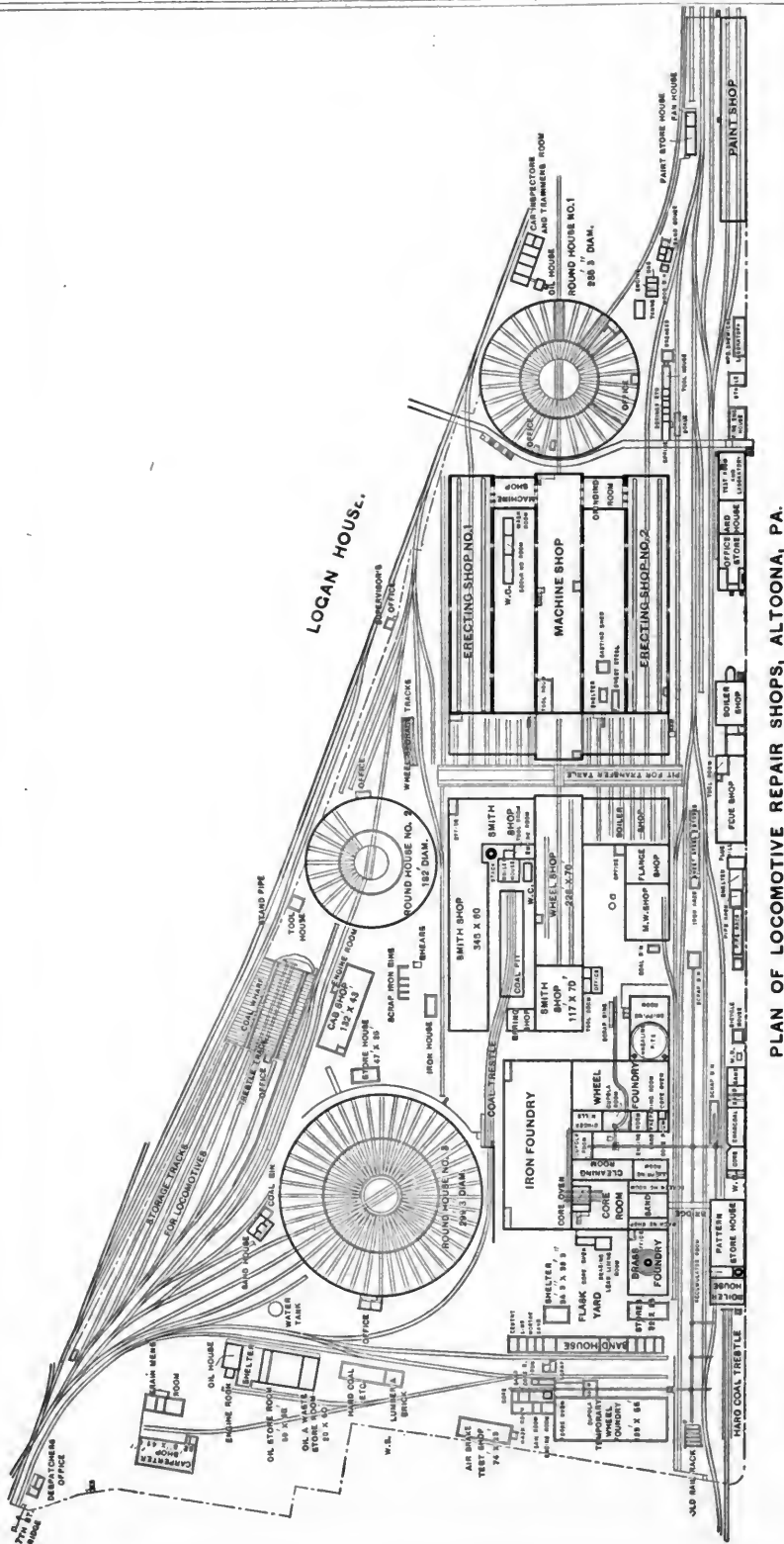


Fig. 1.—Flexible Staybolt.

trouble has been experienced with them in common with all other locomotive boilers from the breaking of stay-bolts. It was observed that more stay-bolts break in steel than in iron plates, and that the tighter the bolts are screwed into the plates the larger the number of breakages were. From this and other facts the inference was drawn that the rigidity of the bolts had much



to do with their failure. Mr. Joseph Nixon, the foreman of the boiler shops, was therefore led to design the form of attachment shown in Fig. 1, which permits of some degree of flexibility in the bolt, and also provides a more secure fastening. It consists of a nut with a tapered thread $1\frac{1}{2}$ inches in diameter which is screwed into the outside plate of the fire box. The hole on the inside of the nut is tapered, and "runs off to nothing" in the thread, which is cut in the outer end of the hole. The point of flexure of the bolt is thus distributed over some distance and is not concentrated at one point. The bolt is riveted over the outside of the nut, as is usual, and the inside end is screwed and riveted into the fire-box plate in the usual way. The nuts were first made of brass, but are now made of malleable iron. They were first applied to boilers in 1892, and they worked so satisfactorily that they have gradually been used more and more, and now orders have been given to apply them to all boilers which go through the shops. Thus far no bolts have been found broken which are fastened in this way. They are put in the upper rows which are most liable to break, and in some engines in all places where the nuts will not interfere with the attachments to the boilers. The drilling of the ends of stay bolts it has been found will not always reveal a fracture if it occurs, and it was partly for that reason and also to lessen the cost of repairs that this method of fastening bolts was designed by Mr. Nixon and adopted by the company.

A good many years ago the Pennsylvania Railroad had in its equipment a number of Winans Camel engines which some of our older readers will remember had fireboxes, the crown sheets and tops of which sloped downward and backward from the barrel of the boiler, and were stayed with ordinary stay-bolts. Later the Pennsylvania Railroad Company built some consolidation engines with similar fireboxes which have been known as Class I engines. It is said of the boilers of these engines that they are the cheapest to maintain of any on the road, as they are also the lightest boiler in proportion to their size of any in use. Having some interest in this we made inquiry and ascertained the weights of three classes of boilers: 1st, Class I, of the kind

described; 2d, Class A, for anthracite coal, but having a wagon top and crown-bars, and Class R, a Belpaire boiler. The following table gives the weights of the boilers as they leave the boiler shops without flues, their heating surface and the weight per square foot of heating surface:

Class.	Weight of boiler.	Heating surface.	Weight per square foot of heating surface.
	Pounds.	Feet.	Pounds.
I.....	11,413	1,259.5	9.06
A.....	16,361	1,205.0	13.57
R.....	18,850	1,731.0	10.89

The weight of the Class I boiler included water grates, whereas the others did not. It will be seen that it weighs 1.83 pounds per square foot of heating surface less than a Belpaire boiler, and 4.51 pounds less than one with crown-bars. In a boiler with 2,000 square feet of heating surface there would, therefore, be a difference of more than 3,660 pounds in the weight of a Belpaire boiler, and one of the Class I type and over 9,000 pounds between a boiler of the latter type and one with a crown sheet supported by crownbars. The comparison is, perhaps, not quite fair, for the reason that the Belpaire boiler was designed to carry a higher pressure than the others were intended for, but, after allowing for this, the fact remains that boilers of the camel type are lighter than any other form in use, and are easier to maintain, not slight advantages. As the objection is sometimes made to them that they do not carry water well, we made special inquiries with reference to that point. The testimony relating to this point was a little conflicting regarding the class I boiler which was probably deficient in steam room. Men who ran camel engines, and still survive, say that they always carried water very well. They had, however, high domes which were very large in diameter, and located at the front of the boiler near the front tube-sheet. If the only difficulty with boilers of this kind is that of carrying water satisfactorily it would, therefore, seem that it is remediable. The figures indicate that the capacity of a boiler of this kind, of a given weight would be about 20 per cent. greater than one of the Belpaire type, and the difference would be still greater if the comparison was made with one having crownbars. These are certainly no small advantages.

It is a curious fact that in piecing out flues in different shops in the country there are a greater variety of methods in use than are employed in doing any other kind of work. At Altoona there is one of the best equipped and most convenient flue shops that we know of. It is a large, well lighted and ventilated building apart from the boiler shop and just south of it. The flues when they are brought in to be pieced are first put into a "rattler," and the scale is cleaned off. The rattlers used here are cylinders of about 30 inches diameter, which are formed by bolting long cast-iron bars of T section to circular discs or heads attached to a suitable shaft. One of these bars is removable, and the flues are put inside of the cylinder through the opening which is left when it is removed. Between the others there are open spaces or slots about $\frac{1}{4}$ inch wide. Formerly flues were rattled dry, but now the practice is to put them into the rattler with broken furnace slag and then conduct a stream of water, by a perforated pipe, which extends the whole length of the rattler—the water entering through the open spaces left between the bars. It is said that a given number of flues can be cleaned by the wet process in less than half the time than is possible if they are "rattled" dry.

After being cleaned the next step is to cut them off to the proper length, and scarf the ends of the flues externally, the piece to be welded on being scarfed internally. They are then driven together, heated in a coke fire and welded in a very simple machine, consisting in a revolving horizontal shaft which enters the inside of the flue. Another parallel shaft carries a roller, about 3 in. diameter and $2\frac{1}{2}$ in. face, which can be raised and lowered in relation to what may be called the bearing shaft, and after the heated flue, which is to be welded, is placed in the latter, the roller is pressed down on the heated joint and the weld-

ing is effected in a few seconds. The two shafts are geared and revolve together. The machines are made by J. Sadler, of New York.

After being pieced in this way, the flues are tested in a hydraulic tester. This is arranged so as to fill the tube with water taken from the water supply. At the same time the water flows into what was originally a pump cylinder of a Westinghouse brake pump, containing a piston. The water enters the cylinder below the piston and raises it up. When the flue and the cylinder are filled the water connection is closed, and compressed air is admitted above the piston in the cylinder. This is proportioned so as to give the requisite pressure in the flue, and the test is thus made almost instantly. After being tested the flues are swaged down at one end, which is ground to receive a copper ferrule. This is brazed to the tube, and is in turn also ground on its outside surface. It has been found that when tubes leak, that the leak is more likely to occur between the tube and the ferrule, and not between the ferrule and tube plate, and that the brazing prevents such leakage.

Another method of putting in flues has recently been tested. This consists in putting the ferrule into the hole in the tube sheet and rolling it before the tube is put in. Afterwards the tube is put in and rolled inside of the ferrule.

This shop has a capacity for handling about 11,000 flues per month, the average output being about 8,000. All the work is done by piecework, as is the case in most of the shops in Altoona, which system is popular with the men and is profitable to the company. The general verdict is that there is no practical difficulty in securing good work by careful inspection, and that it is no more trouble to inspect work under the piece system than it is to inspect the men when they work by the day and keep them up to their duties.

The system of piece work has been very generally adopted in all the shops, even in round house repairs, and in such work as washing windows with the result of a great reduction in cost. The system is generally liked by officers and men and it would be difficult to induce the authorities at Altoona to return to the days work system after the experience they have had. It is said that the piece work system saves 65 per cent. on the cost of labor. There were of course at first many difficulties in introducing this method, one of the chief of which was, the making of a scale of prices, which took three years to perfect, and which now requires amendment at times. Besides the advantages named work is done quicker and can be hurried more than is possible when men are working by the day. In this way more work can be done with a given equipment than is possible with the old method. The inspection is done by the foreman or a special person appointed for that duty. It is upon the inspection that the success of the system of piece work is dependent. It is said that but little trouble is experienced from bad work.

One of the most interesting places in Altoona is the testing department and laboratory, which has acquired a world wide reputation. It occupies a three-story building 40 by 72 feet, located on the south side of the ground owned by the company. The chemical laboratory, under the charge of Dr. C. B. Dudley, occupies the whole of the third story and about half of the second. The first floor is devoted to the department of physical tests, under the charge of Mr. A. W. Gibbs.

The chemical laboratory is very fully equipped with every requisite for analyzing the great variety of materials which are bought and used in the operation of a great road like the Pennsylvania. The purchase of material by this company amount to many millions annually, and cover a great variety of substances. These include metals of different kinds, such as iron, steel, copper, brass, lead, zinc, etc., paints, oils, soaps, petroleum products of various kinds, caustic soda, blue vitrol, sal ammoniac, disinfectants, mineral wool, magnesia, boiler coverings, India rubber, etc., etc. The aim of those who conduct the laboratory is first to establish a standard of qualities which the material that is bought should possess, and then make specifications of these qualities by which they are bought, and to which they must conform. This alone has required an immense amount of investigation,

study and research. At present about thirty-five specifications of this kind have been formulated, and all the materials to which these refer are bought to conform thereto. When the material is delivered samples are sent to the testing department, properly labeled, and designated by the number of the requisition under which it was ordered, and none of the material can be used, excepting in emergencies, until the samples have been inspected and analyzed to ascertain whether they comply with the specifications. As soon as the analyses are made reports thereon are sent to the superintendent of the motive power department, and the holders of the materials are duly notified whether it does or does not comply with the requirements. If it does it is accepted and used, if not the parties who supplied it are notified and it is returned to them. Some of the materials are subjected to both chemical analysis, and to physical tests before being accepted. The ascertainment of the qualities and characteristics, which all these different materials should have of course, implies as has been said an immense amount of special knowledge, and these which have been prepared were evolved as the result of the work of this unique department of the Pennsylvania railroad during the many years of its existence and are the results of much labor, research and experience. The great variety of materials which are bought by and are sold to railroad companies are, of course, subject to all kinds of deterioration, adulteration and falsification. Sometimes this arises from the ignorance of dealers or manufacturers; in others it is more culpable. It is the business of the testing department to ascertain whether the materials bought have the qualities required. There are, of course, some things which require only to be inspected, and not tested, and for that reason inspectors are employed, but these belong chiefly to the physical test department, and are sent wherever their services are required. That a private individual firm or a great company will be liable to be cheated if it does not know what kind of materials are supplied to it, or if its knowledge of what it gets is supplied only in a very casual, desultory and unsystematic way, would hardly appear to require any proof. The Pennsylvania Railroad Company has organized its test department in a thoroughly systematic manner to do what every prudent business man does when he buys anything. The magnitude of the transactions of the railroad company of course requires that the organization and scope of this department should correspond thereto in order to accomplish its purpose. In another article a fuller detailed description will be given of the work which has been and constantly is being done, with some reports of the results which have been accomplished thereby.

(To be Continued.)

Communications.

Sensational Tests of Car Wheels.

EDITOR AMERICAN ENGINEER, CAR BUILDER AND RAILROAD JOURNAL:

The interesting account on page 92 of your June issue of certain "thermal tests" of car wheels, made at Altoona, is calculated to excite alarm and to weaken confidence in cast-iron car wheels.

A little reflection will, I think, convince those who are familiar with the manufacture and use of car wheels that this test is entirely unlike any conceivable conditions, even of severest service. Prolonged action of brakes cannot approximate such a condition, although car wheels are frequently observed to be *very much hotter*, when examined at the bottom of a long descending grade, than your account shows sufficed to crack the test wheels, without any evidence of cracking in plate or brackets.

Pouring an annular lake of molten iron around the rim of a car wheel does not, at all, imitate the condition which obtains when brakes are suddenly and continuously applied, therefore no proper deductions can be drawn therefrom; though the *prima facie* reason why one wheel cracked under such a test and another did not, would appear to be that the cracked wheel had a deeper chilled tread and would, therefore, have proved a more serviceable wheel for the purpose for which it was designed, viz., to show good mileage in actual service.

Some years ago the wheels made at Altoona were cast by what was then called the "sand-flange process," and wheels cast in this

way would, presumably, resist this extraordinary "thermal test" better than similar wheels cast in a chill not provided with the sand flange.

In 1881, when I last visited the Altoona shops, the sand-flange power process had been in daily use for more than five years and it would no doubt be equally applicable to contracting chills which are now generally used.

This process is simply providing a groove about $\frac{1}{4}$ inches wide, $\frac{1}{4}$ inches deep in the flange portion of a chill; this groove is filled with sand, properly packed to preserve the shape of the flange and an annular chamber about $\frac{1}{4}$ inch wide and $\frac{1}{4}$ inch deep with a few vent holes to carry off the steam generated in the sand rammed in the groove, while casting the wheel.

The practical effect of this arrangement was to decrease the chill of the flange of the wheel, without affecting the depth of chill on the tread. This difference would probably be sufficient to prevent the occurrence of a crack through the flange, which would, of course, immediately cause a crack in the brackets, followed by a crack through the plate.

I do not know whether the Altoona wheel was cast in this manner, or whether it was deficient in chill, but I regard the test as a sensational and misleading one, representing impossible conditions and likely to cause unnecessary alarm unless properly understood.

Not having been connected with car-wheel manufacture since 1887, I feel free to criticize this test. C.

[Our correspondent's observation that "the *prima facie* reason why one wheel cracked under such a test, and another did not, would appear to be that the cracked wheel had a deeper chilled tread," it is to be feared is a mere hypothesis, and may or may not be true, but is valueless as a basis for drawing any reliable deduction. Whether the wheels which were broken were or were not cast with a sand flange we are not able to say, neither do we know whether that method of casting "would probably be sufficient to prevent the occurrence of a crack through the flange." In cases like this it is well to keep in mind the maxim "that things which are not quite sure are very uncertain." Nor is it quite clear why the test referred to should be regarded as "sensational." That car wheels break when their rims are suddenly heated to comparatively low temperatures is surely a fact of importance in view of the experience, which is not uncommon, of more or less mysterious breakages of wheels in service, attended at times with loss of life or limb, and always by loss of property. It would or should be more sensational if such a fact did not receive very serious consideration by those who are interested with the responsibility of carrying us safely when we travel on railroads.—EDITOR.]

Indicator Rigging for Locomotives.

EDITOR AMERICAN ENGINEER, CAR BUILDER AND RAILROAD JOURNAL:

There is a mistake in the latter part of the article in your June issue on the Indicator Rigging used on the Pennsylvania Railroad, where it is stated that the rigging illustrated is the development of one used by Professor Goss, whereas it is the development of one first used and illustrated by Mr. Dean or George Strong.

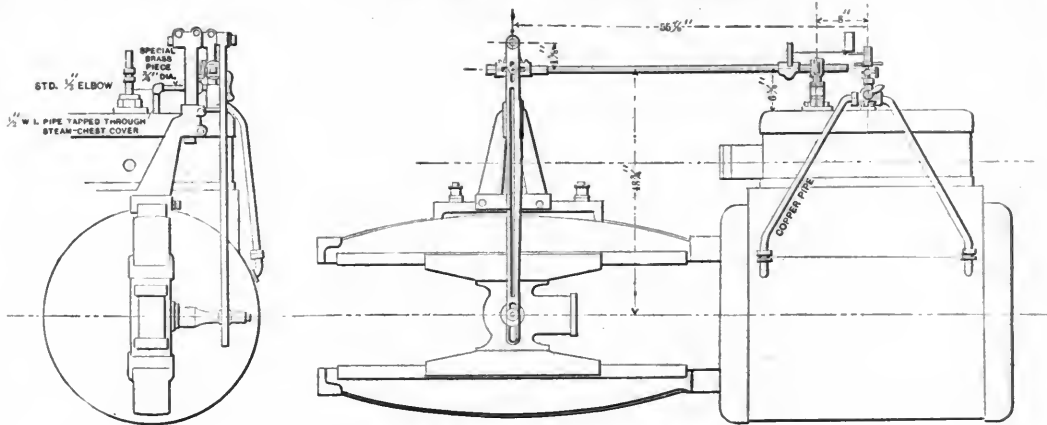
I send you with this letter prints showing the general arrangement and details of our latest rigging, which is a modification of that used by Professor Goss. It was made for use on our new mogul compounds, as the pantograph rigging was not adapted to the increased stroke and higher steam chests of the compounds. The pantograph rigging is an accurate one and has been used at speeds over 80 miles per hour, but service has shown it to possess two disadvantages:

First. The workmanship has to be very excellent to prevent lost motion.

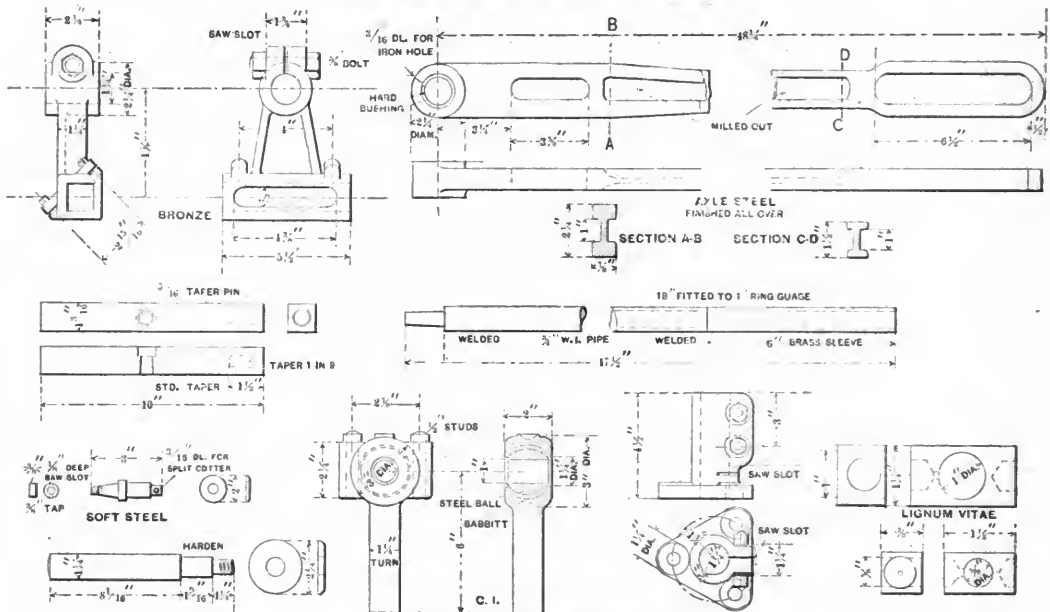
Second. It is too flexible laterally, and the side tremors set up are communicated to the motion rod, and thence to the indicator drum.

The motion shown in the blue prints sent you is an equally accurate and much simpler one, and, as will be noticed, uses several parts of the pantograph motion.

Trial shows that it wears better and is not subject to the same vibration as the other motion, but has not the same range of vertical adjustment. It has provision for taking up the wear where necessary, and the steam-chest bearing for the motion rod is much



General Arrangement of Indicator Rigging.



Details of Indicator Rigging.

better than that illustrated by you in June. Brass sliding blocks in the slots of the lever were found to wear too fast, and have been supplanted with others of lignum vitae, which wear very much better. The details are so plain as to need no explanation.

For engines with a short stroke and high steam chests, the fulcrum of the lever could well be placed between the slots, and would allow a much shorter and stiffer stand, but the angle of the slots to the line of motion would be less favorable, and there might be some trouble from sticking.

In conclusion, I think that where it is necessary to adapt one rigging to a number of engines of different types, the pantograph motion is to be preferred, but where one can afford to make special levers of different lengths, the one shown is most satisfactory.

Yours truly,

A. W. GIBBS,
Assistant Mechanical Engineer, Pennsylvania Railroad,
Alltoona, Pa.

[The prints reproduced herewith need but little explanation. The lever is shown in detail, also the lignum vitae sliding blocks. The lever fulcrum and means for adjusting it are much the same as in the illustrations in our June issue. The fulcrum pin is

clamped firmly in the fulcrum and between the latter and the lever is a motion-rod guide clamped to the same pin. It provides a support for the square end of the motion-rod, and the square end, which is 10 inches long, is drilled for a pin which also passes through the sliding block in the lever. The support for the motion rod at the steam-chest end consists of an adjustable standard with a steel ball in a babbitted socket, the rod passing through a hole in the ball. The method of attaching the cord is the same as in the other rigging.

This rigging and the one previously illustrated are two excellent examples of serviceable rigs, the one illustrated in June being adjustable to a number of locomotives of different dimensions, while the one here shown is simpler and has fewer parts, but is not adjustable to the same extent as the former one. It would probably require a new lever for each class of engine, all the other parts being retained. But as Mr. Gibbs has pointed out, it is a better rig than the pantograph, and while the cost of several levers may be raised as an objection, it should be remembered that the cost of keeping lost motion out of the pantograph will in a measure offset this expense where much indicating is done. —EDITOR.]

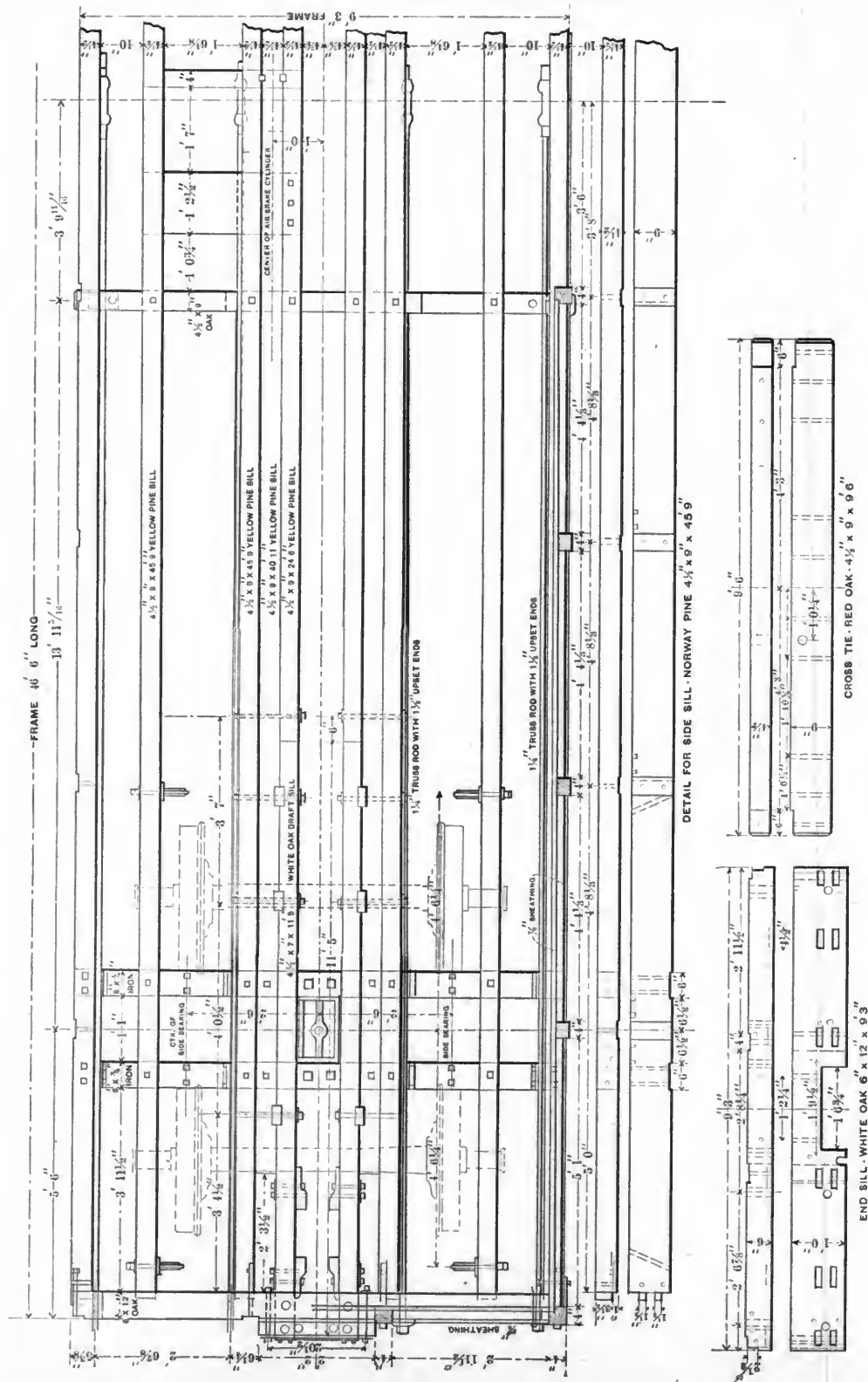


FIG. 1.--UNDERFRAME OF FORTY-SIX FOOT FURNITURE CAR--CHICAGO, MILWAUKEE & ST. PAUL RAILWAY.

Designed by Mr. J. N. Barr, Superintendent of Motive Power.

Forty-Six-Foot Furniture Car—Chicago, Milwaukee & St. Paul Railway.

To meet the need for a furniture car of large cubical capacity on the Chicago, Milwaukee & St. Paul Railway, Mr. J. N. Barr, Superintendent of Motive Power, designed a car, the drawings of which, through his courtesy, we present to our readers. Its inside dimensions are 46 feet in length, 8 feet 9 inches in width and 9 feet 3 inches in least height, and the capacity in weight is 60,000 pounds.

The car is remarkable for its size, though there have been constructed furniture cars 50 feet or more in length; but usually the cars of extreme length have a capacity of less than 60,000 pounds. The most interesting part of this car, however, is the framing, which, upon inspection, will be found to differ from common practice. In the underframes the arrangement of sills is novel. Ordinarily the longitudinal members of a frame for a car of this size would consist of eight sills and two draft timbers backed by sub-

The bolts of the draft lugs pass through the draft timbers only, and their nuts are accessible in the pocket or opening occasioned by the short center sills. The construction described not only facilitates the removal of the draft timbers, but it is believed that will also make it easy to replace a center sill.

The body bolsters are of iron and double. Each truss consists of a 6 by 1-inch upper plate and a 6 by 1-inch lower plate. At the center a large casting extends between the trusses to receive the center plate. The needle beams are 4½ by 9-inch oak. The frame is trussed by four 1½-inch truss rods, with 1½-inch ends.

The upperframes are also worthy of attention. All the posts on the sides and ends of the car project slightly through the outside sheathing of the car. They are not tenoned and mortised into the top faces of the sills, but extend down their sides and are secured by horizontal bolts, in addition to the usual vertical tie rods. It will be noticed that the sills are gained ¼ inch deep for the posts. These posts are 3 by 4 inches in section, except at the doors and corners, where they are 4 by 4 inches. At

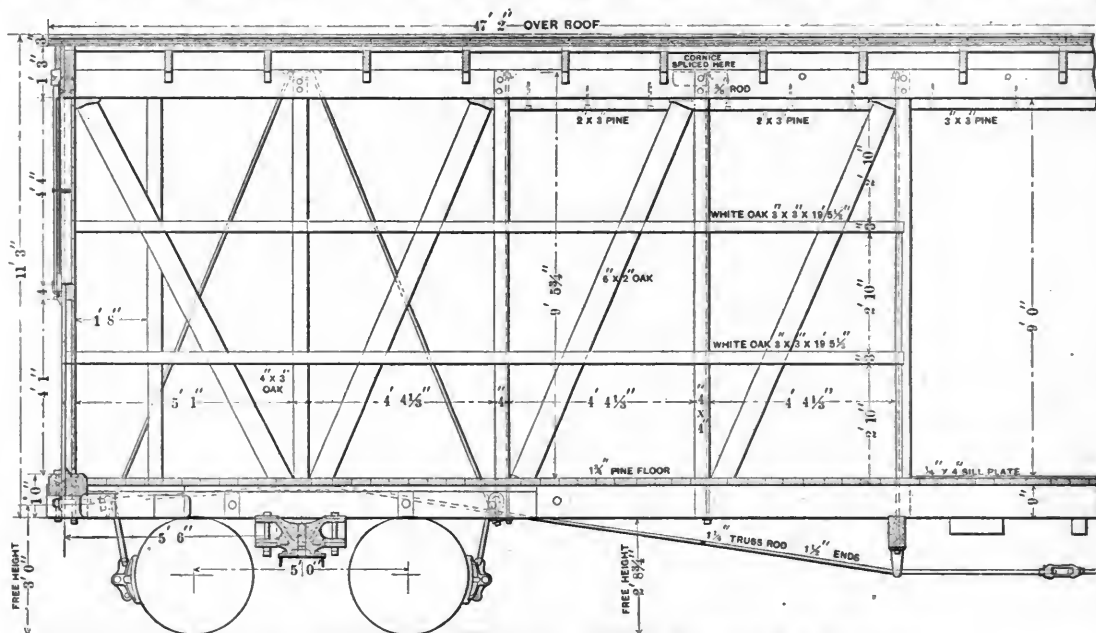


Fig. 2.—Framing of Forty-six Foot Furniture Car.—Chicago, Milwaukee & St. Paul Railway.

sills under the center sills to make them practically continuous. In this car there are the same number of longitudinal members, but, as is clear from Fig. 1, they are all in the same horizontal plane. The draft timbers are placed against the inside faces of the center sills, and against the outside faces of the latter are placed the first intermediate sills. This arrangement brings together in one mass, on each side of the center, three 4½ by 9-inch sills, which extend throughout the length of the car, except that, what we have termed the center sills, only extend to within 2 feet 3¼ inches of the inside face of each end sill. All the sills proper are of yellow pine, and the draft timbers are of white oak and 11 feet 5 inches long, which causes them to extend well beyond the body bolster. From back to back of end sills there are made continuous 4½ by 9-inch yellow pine sills. The end sills are 6 by 12 inches in section and at the center are cut out, not only for the drawbar stem, but also for the ends of the draft timbers.

By this arrangement the only vertical bolts holding the draft timbers are those through the end sills and deadwoods. It is not necessary to enter the car to remove any of the bolts, but all of them are accessible from the outside. The space between the two intermediate sills is sufficient to permit of the entire withdrawal of the long horizontal bolts extending through the three timbers.

the lower end they are cut away so as to leave a foot 1½ inches thick which fits into the gains in the faces of the sills. The upper end is joined to the plates in the same manner. A detail of one of the door posts is given in Fig. 3. The diagonals are of 6 by 2-inch oak and are set into iron shoes at each end. There are two white oak belt rails, each 3 by 3 inches in section. By the construction of the posts, as here shown, there are no tenons and mortises to rot, and repair or replacement of members of the side end framing can be more easily performed and with less disturbance to adjacent parts than in the common construction. It also gives more width inside of the car for a given outside width, because one inch of the side posts is outside of the sills, and the outside sheathing does not cover the post, thus the total gain being about 2 inches. The car is 8 feet 9 inches wide inside, 9 feet 3 inches wide over the sills, 9 feet 4½ inches over the sheathing, and 9 feet 11 inches wide over the eaves.

The trucks for these cars are of the Barber type, patented by Mr. J. C. Barber, formerly Master Car Builder of the Northern Pacific Railroad. They are shown in Fig. 4. The frames are of the diamond type, and carry the springs by means of seats on the bottom arch bars between the column guides. Above the springs are caps separated from the bolster ends by rollers. The upper

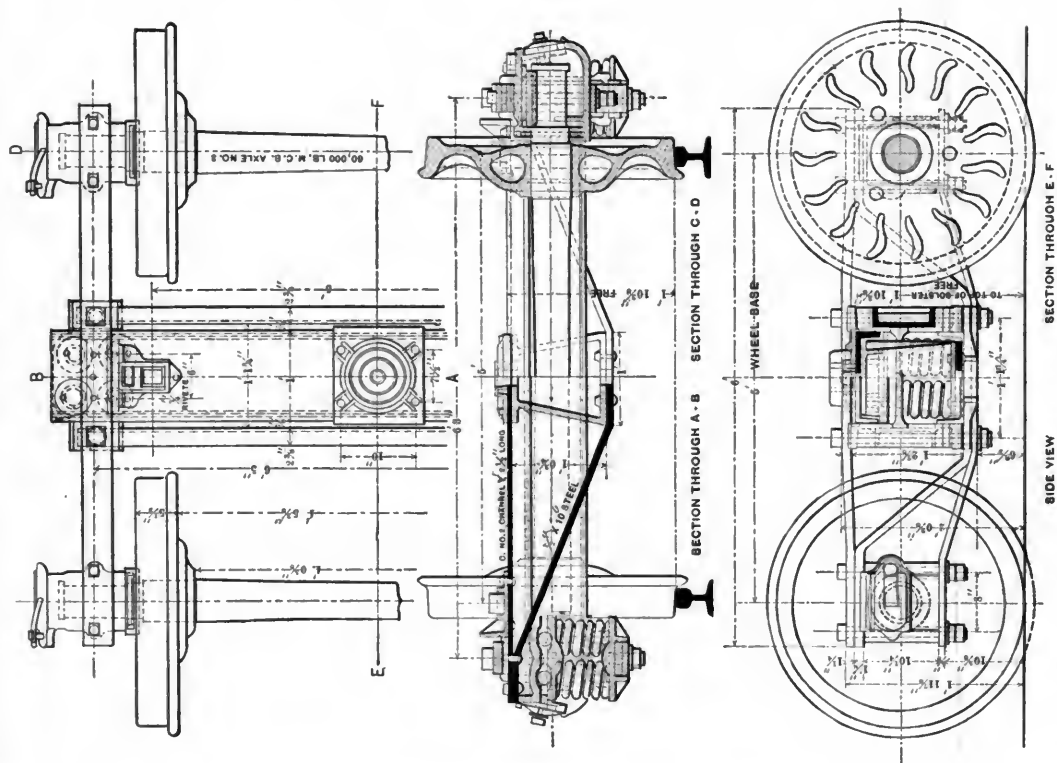


Fig. 4.—Truck for 46-Foot Furniture Car.

Chicago, Milwaukee & St. Paul Railway.

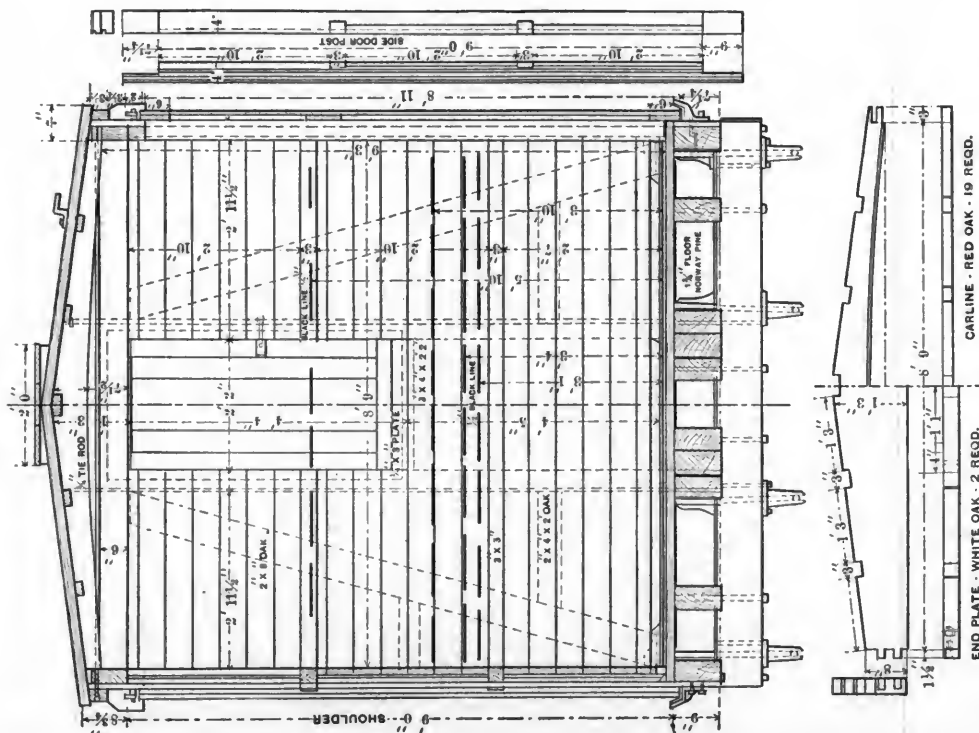


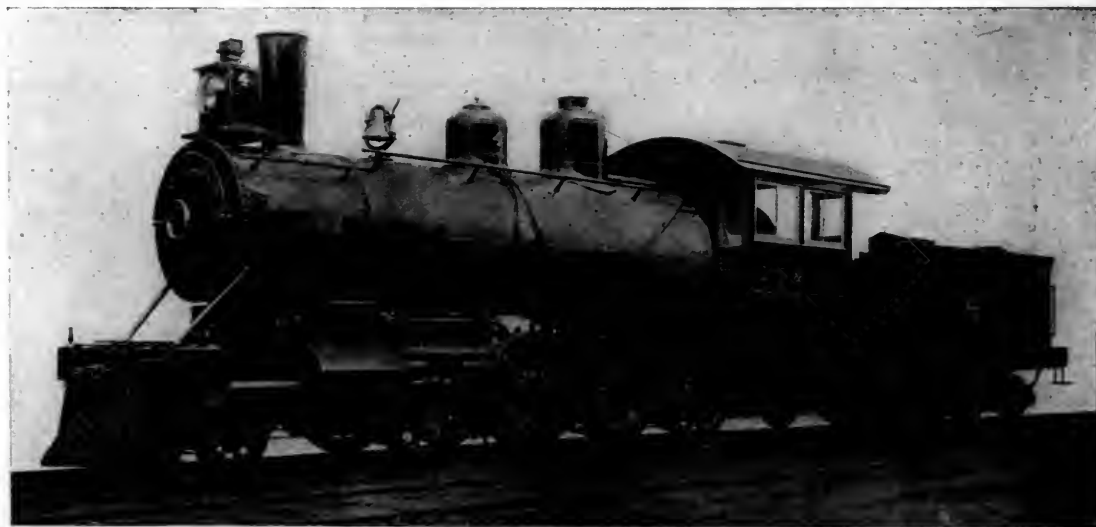
Fig. 3.—Cross-Section of Furniture Car.

CARLINE - RED OAK - 19 REQD.

END PLATE - WHITE OAK - 2 REQD.

Diameter of tubes.....	2 1/4 inches
Length of tubes over tube sheet.....	7 feet 7 inches
" " firebox, inside.....	108 inches
Width ".....	42 3/4 inches
Working pressure.....	150 pounds
Kind of grates.....	cast iron, rock
Grate surface.....	51.78
Heating surface.....	2,049.5
" " firebox.....	148.6
Total heating surface.....	2,198.1
Diameter of driving wheels outside of tire.....	36 inches
" and length of journals.....	5 inches by 30 inches
" " and length of journals.....	5 inches by 9 inches
Type of tank.....	Level top
Water capacity of tank.....	4,000 U. S. gallons
Fuel.....	250
Weight of tender with fuel and water.....	76,800 pounds
Type of brakes.....	Westinghouse American automatic

"Air Pumps. Their Troubles and Treatment, and Tools for Making Repairs."—Otto Best, chairman; Alex. B. Brown, H. F. Bickle, G. S. Hale, Jno. Hume, Jr., C. P. Cronin, Fred Hain.



Fuel.....	Bituminous coal.....
Gage of track.....	1 feet 8 3/4 inches.....
Total weight of engine in working order.....	17,800 pounds.....
" " " " on drivers.....	132,800 ".....
Driving wheel base of engine.....	15 feet 6 inches.....
Total.....	23 " 6 ".....
" " " " and tender.....	63 " 10 1/2 ".....
Height from rail to top of stack.....	11 " 11 1/4 ".....
Cylinders, high pressure, diameter and stroke.....	20 inches by 28 ".....
" " " " low pressure.....	30 " 38 ".....
Slide valves.....	Richardson balanced.....
Piston rods.....	Steel, 3 3/4 inches diameter.....
Type of boiler.....	Straight.....
Diameter of boiler at smallest ring.....	64 inches.....
" " " " back head.....	67 ".....
Crown-sheet supplied by radial stay.....	1 1/4 " diameter.....
Stay bolts.....	1 inch diameter, spaced 1 inches from center to center.....
Number of tubes.....	240.....

Committee on Arrangements.—F. M. Nellis, chairman; Otto Best, Lawrence Hahir, W. C. Walsh, J. A. Jesson.

CONTRIBUTIONS TO PRACTICAL RAILROAD INFORMATION.

Chemistry Applied to Railroads.—Second Series.—Chemical Methods.

XLX.—Method of Determining the Shade of Paints.

BY C. B. DUDLEY, CHEMIST, AND F. N. PEASE, ASSISTANT CHEMIST,
OF THE PENNSYLVANIA RAILROAD.

EXPLANATORY.

Perhaps no characteristic of paints gives more trouble, both to the manufacturer and to the consumer, than the shade. To the uninitiated, red paint is red, green paint, green, and blue, blue; but the person who attempts to make a sample of paint which shall match any given color, be it red or green or blue or any other color, either with or without a name, soon finds that there may be hundreds of shades of what is commonly known as one color, and that only one of these is an exact match for the color he has in hand. Oxide of iron, as is well known, is commonly said to be red in color, but the number of shades of the red of this pigment are almost as numerous as the different sources from which it is obtained. Each mine of this material used as a pigment apparently has its own shade, and each batch of artificially made oxide of iron, so far as our experience goes, differs more or less in shade from every other batch. The truth of this statement may be very easily verified by obtaining samples of the various colcothars, crocus martis and cheaper grades of Indian and Venetian reds in the market, most or all of which are artificially prepared, and compare them for shade by the method described below. The results obtained, we are confident, will fully justify the statement made at the beginning of this article.

The method of producing the shades desired in pigments is twofold; first, by varying the conditions under which the pigments are produced in the manner known to color makers; and, second, by means of mixtures. The latter is obviously the method that must be used by the color grinder, and the painter or consumer. But in order that the color maker, the color grinder or the painter may know what he is doing, or when he has secured the desired result, it is obvious that he must have some method of determining shades. Furthermore it is well-known that large amounts of paints are used by railroads for a definite purpose, such as painting freight cars or passenger cars, or for buildings and fences along the line. These paints have definite shades, established after considerable care and study. They are, many of them, bought on definite specifications, and always in successive shipments, and from different manufacturers. There must, therefore, be some method conscientiously used of determining the shades of these various shipments, or the utmost confusion and mixture of colors will result. It is the object of the present article to describe such a method.

Several ways have been suggested and employed with more or less success in determining the shade of paints. They are all based, at least so far as our experience goes, on comparison of the sample in hand, with some other sample which represents the shade desired. This comparison has been made in three ways:

I. Since the end desired, viz., that the painted work when finished shall be of the required shade, perhaps the most natural and most universally employed method of determining shade, has been to have previously prepared a small board or other surface painted with the standard or desired shade, and compare this with a similar one painted with the material whose shade is in question. The comparison is usually made by placing the two boards side by side and examining them at different angles and in different lights. This method has been very largely used, and was for a long time, perhaps, the only one in general use. It has the advantage mentioned above of enabling the judgment in regard to the paint in question to be based on the finished work, and this is unquestionably a very strong point in its favor, but the disadvantages of this method are also very great, so much as to render it almost impracticable for testing successive shipments. These disadvantages may be briefly enumerated as follows: *First*. Paint

when it is freshly applied does not always have the same shade that it does when the same paint is dried, owing, perhaps, to change of position of some of the constituents of the pigment during drying, and possibly to chemical changes between the oil and pigment during the same operation. Both these phenomena are known to occur during the drying of paint, and both are known to affect the shade. Moreover, differences in surface, viz., the glossy surface due to the liquid, or the more or less dead surface due to dried paint, have an influence on the shade, so that it is clear that unreliable results will be given by comparing a freshly painted surface with the standard dried sample. If this method of determining shade is used, therefore, it is evident that the paint to be tested must be allowed to dry before comparing with the standard, or some of the standard must be freshly mixed each time, and the comparison made on the undried paints. The former requires far too much time for successful use in testing shipments, and the latter is laborious and moreover sacrifices the strong point of this method, viz., a judgment obtained from the finished work. It should be stated that in common use the standard is prepared once for all, and is kept, sometimes without exposure to the light, but more commonly hanging on the wall in the shop. This leads us to the *second* objection to this method, viz., the standard changes with time. The change in paints which results from exposure to the light, the air and to the action of water is far too well known to require especial comment, and while it is quite possible to exclude the action of water on the standard board, and by proper and reasonable protection to diminish the action of light, it is still, we believe, impossible to prevent any paint, and especially those containing organic coloring matter, from slowly fading. A *third* objection to this method, at least if the dried standard is used, is that the various ingredients used in mixing the paint affect the shade. This is especially true of the japan drier, which, as is well known, is dark in color, and also by its action on linseed oil changes that to a dark color. In order to make a fair comparison, therefore, with the dried standard, it would be essential to use the same amount of the same japan, since japans differ widely in their composition, as was used in preparing the standard board. It needs no extended comment to make clear how difficult this would be. *Fourth*, and finally, this method does not give very sharp results, that is, does not enable fine distinctions in shade to be made. Inequalities and irregularities in the surfaces, the difficulty of getting the light to strike the two samples at exactly the same angle, and especially the absence of any sharp line of demarcation between the two, all conspire to render the indications obtained by this method general, rather than sufficiently definite to enable the operator to do justice to both producer and consumer in his tests.

II. A second method of determining shade, which has been tried somewhat, is by means of the Lovibond tintometer. This instrument may be briefly described as a flat wooden tube, open at both ends, about 14 inches long and 3 inches broad and an inch and a half thick. At one end a partition divides the tube lengthwise for a short distance. At one side of the partition are arrangements for holding small colored glasses, and on the other side, arrangements for holding the sample to be examined. The instrument is used by placing the material to be examined so that the light will pass through or from it on one side of the partition to the eye looking into the other end of the tube, and then placing a pure white surface on the other side of the partition, so that light from it will pass to the other eye. Now a series of colored glasses of varying colors and strengths being introduced between the white surface and the eye, it is possible under favorable conditions to get the same color that the sample to be examined shows. The glasses being numbered and marked according to a previously arranged nomenclature, it is possible to, in reality, make an analysis of the color which is being worked on. It is obvious that as applied to determining the shade of paints, it is only necessary to make an analysis of the standard sample, and then see if the successive shipments give the same analysis. Our experience with this instrument has not been very large, but we have experimented with it enough to find as follows: *First*. The

source from which the light comes, makes considerable difference in the analysis. It is recommended to use the instrument in a "perpendicular light from a dull gray sky." But such light is not always available, while the testing of shipments must go on, whether good light is available or not. This difficulty, therefore, is quite a serious one. *Second.* Different operators are not able to make the same analysis, all other conditions, being as far as possible, the same. Indeed, the same operator, using one eye at a time to make an analysis, will not get the same results with both eyes. It is obvious that this difficulty, might lead to serious trouble, if the analysis by test of the consumer, led to the rejection of a shipment, while the analysis by the expert of the shipper showed that the material passed test. *Third.* The analysis of the standard even under favorable conditions is slow and laborious, and while, with sufficient time and care, close results and fine distinctions can be made, it would be quite out of the question to make an analysis of the standard and of sample from shipment each time the instrument was used. This procedure would probably eliminate the two difficulties mentioned above to a greater or less extent, but such a procedure would require more time than could be given for determining shade. We are far from saying that such modifications and fixing of conditions cannot be introduced into the tintometer as would make it entirely a practicable instrument for determining shades, but our studies have not yet led us to such results.

III. The third method of determining shades which we have had experience with is described below:

OPERATION.

Have the pigment representing the standard shade in the dry condition, that is unmixed with oil or any other menstruum. Then if the material to be tested is in the dry condition likewise, weigh into an agate mortar a gram of the standard, and add as much pure fresh raw linseed oil as will form with the pigment a stiff paste. Rub with the pestle until the paste will stand a previously decided upon test for fine grinding. A satisfactory method of testing fineness of grinding is described under the heading, "Method of Determining the Fineness of Grinding of Freight Car and Passenger Car Colors," published in the June number of this journal. Mix the same amount of the material to be tested with the same amount of oil used with the standard, and rub with the pestle to a condition as to fine grinding at which it is desired to know the shade. Now, with a spatula or glass rod, transfer a little hillock of each of the samples of paste to a small piece of clean glass, placing them near each other. Lay on top of the two hillocks a thin cover glass, such as are used by microscopists, and press it down until the two samples unite. If they are of exactly the same shade, there will be no line of demarcation between the two. If they differ in shade, this line will be more or less clearly marked. If the material to be tested is in the paste form, or mixed with any menstruum whatever, it is essential to mix the standard pigment with the same amount and the same kind of menstruum as is characteristic of the material to be tested before the comparison is made. Also the fineness of grinding of the standard must be that previously determined upon, otherwise the operation is in all respects the same as that described for dry pigments.

APPARATUS AND REAGENTS.

An agate mortar is best for preparing the samples for testing, but a porcelain mortar or other means of mixing the oil and pigment and bringing the paste to the proper fineness can be used.

Strips of ordinary glass may be used to put the hillocks of paste upon, but for the cover it is essential to have the glass thin and as free as possible from color, since the color of the glass affects the shade. What are known in the market as "microscope slide cover glasses," about three-quarters of an inch in diameter and as thin as possible, work very nicely.

In regard to menstruum, pure raw linseed oil, not too old and fatty, and of clear amber color, is best. Oil that is discolored from any cause should not be used.

CALCULATIONS.

Obviously no calculations are required by this method.

NOTES AND PRECAUTIONS.

It will be observed that this method is simply a comparison of the material to be tested with a previously decided on standard, under certain definite conditions.

The shade of paints is affected quite considerably by the fineness of the particles of the pigment, and also, apparently, by the intimacy of the mixture of the pigment with the menstruum. The shade of some pigments, notably scarlet lead chromate, is very perceptibly changed, or, indeed, almost destroyed, by fine grinding; other pigments develop their most desirable shades only when finely ground, and all pigments, so far as our experience goes, vary their shades more or less according to the fineness of the grinding. It is obvious, therefore, that some standard of fine grading must be established before a standard of shade can be decided on. The pigments of paints to be compared with the standard may or may not be brought to the same fineness as the standard, according to the information desired from the test.

The shade of pigments is often so completely changed by mixing with some menstruum that no satisfactory results can apparently be obtained by comparing dry pigments. A very good illustration of this may be secured by comparing white lead and sulphate of lime or gypsum, both dry and ground in oil.

With some pigments a change in shade occurs during the first 12 hours, after mixing with the oil, so that if the standard is mixed and the comparison made immediately the same result will not be obtained as if the standard is allowed to stand 12 hours after mixing. As the principal use of the test is to see whether successive shipments of ground material have the standard shade, it is essential with these pigments to mix the standard and allow it to stand at least 12 hours before making the test. We are unable to explain the change in shade of the standard which results from standing. The change is beyond doubt.

The pigment representing the standard shade should be kept in a place free from moisture, and, as previously stated, should not be mixed with the menstruum until needed for use. All attempts to keep a standard shade in any other way have, so far as our experience goes, resulted in failure, while with many pigments this method gives entirely satisfactory results. It is possible that some pigments, even in the dry condition, will slowly change in color; many, if not all, certainly will if mixed with oil or other menstruum and exposed more or less to light and air.

The principal use of this method being, as previously stated, to test shipments of material bought in the paste form, and on definite specifications as to proportions of pigment and liquid and as to fineness of grinding, a very large number of tests can be made in a day. In describing the method an attempt has been made to give it a little more general application.

It may be urged as a defect of the method that it tests the material at a point in its history so far away from the finished work that really the consumer is hardly fairly dealt with. But as has already been shown the materials which the consumer adds to the paint to enable it to be spread, change the shade, and it certainly cannot be fair to hold the manufacturer responsible for what the consumer does to change the shade. Moreover, when testing shipments, as is seen, the test is applied at that point in the transaction where the material passes out of the control of the producer and into the hands of the consumer, a very fitting place, it would seem, to apply all tests and decide all questions affecting the material.

It will be observed by those who make tests in the manner described above, that the material to be tested either is the same shade as the standard, or it is not, and there is no means of accurately telling how near any given material is to the standard shade, nor without experiment to say what to do to the material under test to bring it to the standard shade. In other words, since commercial materials are rarely in any respect exactly what is aimed at, and since with all materials small variations from the requirements of the specifications are allowed, it may seem that a method so rigid as this one would be inapplicable. It was hoped that the tintometer would enable this difficulty to be met by making it possible to say how much any material might vary

from standard shade and still be acceptable. As already stated, this has not yet been found to be possible. In actual practice what is done is to accept shipments that come very close to the standard and reject those farther away. The method described above is extremely delicate, but after a little experience is obtained in its use it is not difficult to use it in such a way as to do no injustice.

Mill Heating from the Hot Well.

In a paper read before the New England Cotton Manufacturers' Association, Mr. George W. Weeks described a novel method of heating employed in one of the buildings of the Lancaster Mills, Clinton, Mass. The building is 116 feet \times 109 feet \times 74 feet high, with about 60 per cent. of the wall area occupied by window openings, none of which were supplied with double windows. The heat for warming the building is obtained from the water discharged from the hot well of the compound engine that furnishes the power, while the air heated is put in motion by the flywheel of the same engine. The system has been in use four winters. Mr. Weeks says:

After consulting with Mr. H. S. Robinson it was decided to put in on trial his system of heating air by means of water from the hot well of engine and add thereto a small engine and blower for use nights and Sundays when the large engine was not running.

The ordinary Corliss flywheel would force sufficient air for this purpose without alteration (we find the air pressure in one of our Corliss wheel pits to be equal to $1\frac{1}{2}$ inches of water), but the wheel of the Wright engine used in the mill being made with arms so shaped as to pass through the air with the least resistance, we found it necessary to add "wings" to them. This wheel is 16 feet in diameter and runs at a belt speed of 4,000 feet per minute. After the wings were attached we obtained a movement of 8,000 cubic feet of air per minute through the flues and mill with an expenditure of three horse-power, as shown by the indicator.

The air is taken mostly from the basement, where it enters from out-of-doors and largely from the connecting boiler-house.

The heater is situated in the air duct leading to the flue, and consists of eight sections, each 42 inches high by 28 inches wide, with 24 $\frac{1}{2}$ -inch pipes, each 90 inches long. These sections are connected by pipe with the hot well, and so arranged that the end covers and diaphragm causes the hot water to flow by gravity through half of the pipes in one direction and return through the other half, and then continue through the other sections in the same manner, and discharging where the air enters, so that the air is always coming in contact with hotter water.

Small pipes were used in order to obtain the largest amount of heating surface in a given space, but as we find we have more heating surface than is needed, it would have been better perhaps to have used larger and fewer pipes so as to offer less resistance to the passage of the air.

With water from hot well at 115 degrees Fahr., we heat the air to 100 degrees Fahr. In one test air was taken directly from out of doors at a temperature of 26 degrees and sent to the mill at 107 degrees, with water taken from hot well at 123 $\frac{1}{2}$ degrees and discharged from heater at 97 $\frac{1}{2}$ degrees. We find in practice that the air is heated to within about 10 degrees of the water used.

As stated before, we put in a small engine, fan and blower to heat the mill before the large engine was started, and to heat it also nights and Sundays during the winter. It would have been cheaper to have put in steam pipes in the old way, and if one does not object to pipes the expense of the extra engine and blower may be saved.

While heating the mill in December, before the large engine was started, we ran the fan engine, exhausting the steam in the same heater. After the large engine started we drove the fan by belt from this engine, and while the walls were still wet, the mill having just been completed, we forced 12,000 feet of air per minute into it, this being sufficient to heat it while in that condition. This required 8.81 horse power, as shown by indicator on engine. As soon as the "wings" were put on the arms of the flywheel we started the air from that, and, as stated before, we heated the mill with 8,000 cubic feet of air per minute, as the looms were nearly all then in operation, and we found that to be sufficient. It took 3 horse power only to furnish this air from the flywheel.

We did not rig up to run the "blower" at a speed to force 8,000 feet per minute, but judging what it would take from the 12,000

feet, it would doubtless require $5\frac{3}{4}$ horse power to force 8,000 feet, or nearly double that required by the flywheel.

We find that it requires about double the heating surface to heat with water that it does to heat with steam, but as water heaters have to sustain no pressure, they can be furnished for a very little more than steam heaters made in the usual way.

Hot or cold water can be showered into the duct in the usual way when desired. When the weather becomes warm enough, so that no heat is required in the mill, the water from the condenser is turned off, and the engine flywheel continues to force the same amount of air through it for ventilating and cooling, and for this latter purpose we can turn cold water through the pipes in the same manner as water from the hot well.

During the time this plant has been used, it has required no repairs and has demonstrated that it will heat and ventilate the mill during the running hours with no expenditure for steam or power beyond the three horse-power added to the engine as stated; that 100 degrees temperature is sufficient to satisfactorily heat the mill, and that the air can be heated to this temperature, with water from the hot well with no loss of power, and our experiments tend to show that it is more economical (when the uptakes are built into the walls) to send a larger amount of air at a lower rather than a smaller amount at a higher temperature. Air heated to 97 $\frac{1}{2}$ degrees at heater is delivered to the fourth story at 94 $\frac{1}{2}$ degrees, showing a loss of only 3 $\frac{1}{2}$ degrees, while air at 124 degrees at the heater was delivered at the fourth story at only 113, showing a loss of 11 degrees.

The Freight-Car Repair Shops of the Southern Pacific at Sacramento.

The Sacramento *Weekly Union* has been publishing an entertaining series of shop notes relating to the car shops of the Southern Pacific at Sacramento, and the last one gives the following facts regarding the freight-car repair shops:

"The shop itself is located at the extreme northern part of the works, and extends from a point at about Third street to the river front. It is the largest and most important of its kind on the Pacific system.

"All cars requiring heavy repairs or rebuilding are sent here, where they undergo a thorough inspection, and, if it be found advisable, are again placed in serviceable condition. If, on the other hand, they be found unfit for further service, owing to age and decay, or from being in a badly damaged condition, the car is torn to pieces, the trucks laid aside for future use on another car, the iron-work assorted and the woodwork otherwise disposed of, usually being used for fuel.

"In this shop are repaired and rebuilt about 700 cars monthly, or 8,400 during the year. The amount of material used monthly is estimated at about 60 carloads, which includes lumber for the floors, roofs and sheathing, timber for the sills and bolsters, and the iron-work used in the construction and repair of cars.

"Many of the cars turned out are painted all over, and in such cases the old tedious process of brush work is relegated to a back seat, and the labor performed by means of an air machine. A vessel, not unlike an ordinary sprinkling can in appearance, though considerably smaller, is so arranged that the air, which is procured from pipes distributed throughout the shops by a system of pipes, is forced under heavy pressure into an opening in the nozzle of the paint tank, which has been filled with paint, thereby forming a vacuum and drawing out the paint through a small valve with great force, so that it reaches the car in the form of a fine spray, penetrating the wood, thus turning out a clear, even and satisfactory piece of work.

"Some idea can be realized of the rapidity by which this little 'pneumatic gun' does its duties, when a flat-car can be given a coat in about five minutes and a box-car in 25 minutes, when handled by one who understands how to manipulate it. The car is then numbered, lettered and stenciled, and is again ready for the road.

"Almost all work done at this shop is conducted under the 'piece rate system,' which has proven to be entirely satisfactory both with the employees and the company, as the rates are always fixed so that the mechanic need do but a fair day's work for a correspondingly fair day's pay.

"As previously stated, a large amount of work is done at this shop, as everyone will understand, when it is considered that each month about 650 sills and 500 draft timbers are used, 120 floors laid, 70 roofs and about 350 California couplers applied.

During the month just passed, 31 carloads of 'scrap' were taken from the repair shop.

"This department is under the direction of C. A. Phipps, and he is ably assisted by his corps of under-foremen, and over the entire car-repair plant is Master Car Builder Benjamin Welch, upon whom the mechanics and laborers, in the fullness of their admiration, love and respect, have conferred the title 'Uncle Ben.'"

Annual Convention of the Master Car and Locomotive Painters' Association.

The twenty-seventh annual meeting of the Master Car and Locomotive Painters' Association will be held in New York City on the 9th, 10th and 11th days of September, 1890, convening at 10 o'clock A. M. on Wednesday, the 9th, at the Park (Fourth) Avenue Hotel, which has been chosen as the official headquarters of the association. The local committee of arrangements has secured a special rate of \$3 per day, American plan, and those who expect to attend the convention are requested to engage rooms at an early day, stating length of time the room is wanted, and to avoid any disappointment, those engaging rooms should request the proprietors, Wm. H. Earle & Son, to send them the number and location of room.

The list of subjects to be considered is as follows:

1. The application of compressed air in burning off cars.
2. The cause and prevention of the flattening of varnish on coaches and engines.
3. Is it advisable to paint locomotive jackets, either planished iron or black steel? If so, which is the best and most economical method?
4. Essay "Painting Galvanized Iron."
5. Can a coach be painted to meet the necessary requirements with four coats of paint, or as otherwise termed, the enamel process and retain the same general appearance and durability as when painted under heretofore prevailing methods?
6. The practical painting of a locomotive.
7. Essay. Is it good policy to house passenger cars at terminals? If so, can our companies afford it?
8. Which is the best method of painting superheated parts of locomotives, viz., dome casings, cylinders, steam chests and extension fronts?
9. Which is the most economical and durable, a sandpaper or a pumice stone surfacer?
10. Spontaneous combustion in the railway paint shop. Its cause and prevention.
11. Report from Committee on Tests.

The Mileage of Chilled Cast-Iron Wheels in Freight Service.

The great improvements made in chilled iron car wheels in recent years, in a manner, exemplified in their increased mileage. Notwithstanding the greater weights carried on them the mileage is much greater now than it was 10 or 15 years ago, and there is a good prospect that the first-class wheels put into service at the present time will maintain, if they do not add, to the reputation of such wheels.

To those who have not followed the mileage records closely there is much of interest in the following statement showing the service of chilled iron freight-car wheels on the Chicago, Milwaukee & St. Paul Railway, and kindly furnished by Mr. J. N. Barr, Superintendent of Motive Power:

CHICAGO, MILWAUKEE & ST. PAUL RAILWAY COMPANY.
Office Superintendent Motive Power.
Statement showing service of freight-car wheels.

Calendar year.	No. of freight wheels made or bought.	Freight car mileage.	Number of freight cars.	Number of freight wheels in service.	Average mileage.	Average life of wheels.		
						Years.	Mon's.	Days.
1855	22,795	215,159,302	19,402	155,215	76,968	6	11	15
1856	19,459	236,110,419	21,385	171,030	97,090	8	9	15
1857	24,721	250,771,965	21,678	173,424	81,122	7	0	1
1858	24,162	261,400,022	22,544	186,352	85,544	7	5	17
1859	26,015	290,890,286	22,776	182,208	77,181	7	0	1
1860	15,823	263,983,815	23,894	190,912	135,168	12	0	24
1861	12,810	305,482,841	25,674	205,292	190,776	16	0	12
1862	17,340	334,943,674	26,308	210,372	151,526	12	1	18
1863	17,832	312,503,242	27,963	225,612	114,240	12	10	24
1864	11,647	275,300,335	27,800	222,400	189,784	19	1	4
1865	14,219	289,316,350	27,687	224,408	162,776	15	6	26

The column headed "average mileage" is obtained by dividing the total car mileage on the road during the year by the number of wheels removed. For instance, if 10,000 wheels are in service, and 1,000 are removed each year, the average length of service would be 10 years, and the average mileage would be 10 times the

yearly mileage of the cars. This, of course, does not give accurate results for any particular year, but does give a definite and correct comparison when extending over a period of years, so that the figures really show the average mileage of all wheels removed for any cause whatever.

It will be noticed that in the last six years the average mileage of the wheels removed fluctuates from over 133,000 to more than 190,000, while in previous years it never reached 100,000 miles. Another striking feature of the table is the sudden rise in average mileage between the years 1889 and 1890. This we are not able to explain fully, but it might be stated as in part explaining the sudden rise and the higher average mileage after 1890 than before that date that since the date mentioned a very large percentage of the wheels in service were cast in contracting chills. But whatever may be the cause or causes which have operated to increase the average mileage of cast-iron wheels, the result is most gratifying and is not confined to any one road. The figures speak well for the continued use of such wheels under the constantly-increasing freight loads.

It doubtless will be a surprise to many to know that the average life of a good cast-iron wheel in freight service is more than 15 years and that some of them even run for 20 years. Yet such is the fact and more than one road can testify to it. In a discussion at the recent M. C. B. convention one member mentioned this long life of cast-iron wheels, and doubtless others could furnish additional evidence of their durability.

The Introduction of Our Engineering Practice in the South American Republics.

In the last ten or fifteen years several spasmodic attempts have been made by American manufacturers to build up a foreign trade in their products, and signs are not wanting at present of a greater, more widespread, and (what is of greater significance) a decidedly more systematic effort that is being exerted in this direction. The organization of a national association of manufacturers, one of whose objects is to further the foreign trade in American manufactures, and the visit of a committee of its leading members to South America to look over the field there, are indications of the interest which manufacturers in this country are taking in foreign markets.

Another important project and one that should command the attention of manufacturers of all kinds of railway supplies, machinery, machine tools and materials for the construction of roads, docks, bridges, buildings, etc., is that which the well-known firm of Flint, Eddy & Company, of New York, are now undertaking. This firm has been engaged for years in the introduction of constructive materials made in the United States into the other countries on the American Continent, and some of the largest orders placed in this country by South American parties have been given through their agency and largely as a result of their well-directed efforts. Believing that the time has come when a larger part of the trade with these countries can be obtained by reliable firms in the United States, they are preparing to represent a greater number of manufacturers and builders of all kinds of machinery and engineering supplies, and expect to place in the hands of possible purchasers an amount of information about machinery and materials obtainable here, that will facilitate and increase the business with this country.

One of the methods to be employed in presenting this information to foreign purchasers is the publication of a book of information, copies of which will be distributed among mechanical and civil engineers in responsible positions, managers of important enterprises and others who are or may soon become purchasers of machinery or material. This valuable work is now being compiled and will contain fully one thousand pages about 9 inches by 12 inches in size. The reading matter on each page will be arranged in three columns, one in Spanish, one in Portuguese and the other in English. The scope of the work can be judged from the general divisions under which the information is grouped, which are as follows: Railroads, Lake and River Navigation, Public Works, Electrical Appliances, Special Industries (which will prin-

cipally comprise ice-making machinery and sugar-making machinery). These general divisions are sub-divided until they include in systematic arrangement everything needed in the construction, operation and maintenance of works, structures or industries suggested in the general divisions of the book.

The information given in each case will, as far as possible, consist in specifications of materials, descriptions and illustrations of machinery, advantages of same, prices, weights assembled, weights as packed for shipment, etc., all weights and measurements given in both the English and metric systems, and the whole so arranged as to give the reader an accurate knowledge of what is obtainable in the markets of the United States, as well as furnishing him an outline of the best practice in this country. A person consulting the book will thus be able in many cases to place his order without a disheartening amount of correspondence and cabling for information, with its attendant delay and expense. As the book illustrates and describes only the best, it will also be a testimonial to the excellence of American manufactures, and being printed in a language the intending purchaser can understand, should help him wonderfully and should open the way for a profitable and satisfactory business.

The compilation of this book is in charge of Mr. Emilio Del Monte, a civil engineer, who has spent much time in Cuba and South America and is thoroughly conversant with the requirements of those for whom the book is intended, and when it is published he will go to those countries, and possibly to South Africa also, in the interests of Messrs. Flint, Eddy & Company.

That such a reliable and well-informed firm should be making such extensive preparations for an enlarged business with foreign countries certainly speaks well for the prospects of American manufacturers in those markets. Familiar as they are with all the conditions of trade in those countries, they would hardly engage in such an enterprise without every reasonable assurance of ultimate success. To those who are desirous of finding a market in the countries mentioned there is thus afforded an excellent opportunity. The firm in the course of its successful career has attained a high standard in the opinions of those with whom it has done business, and its knowledge of business methods in the countries into whose markets it enters American goods are both factors that point toward success in the present undertaking.

They manifestly need the hearty co-operation of American manufacturers and builders, and we think this will certainly be given them. Our manufacturers not only need other markets than those at home, but they realize keenly as the result of industrial events in this country during the last three years that a foreign trade of considerable dimensions will help them to keep their business going with more regularity and profit than where they are dependent on the home market alone. Skilled labor and inventive genius have done so much for American industries that the result of a competition with other nations in foreign markets cannot be otherwise than successful. Messrs. Flint, Eddy & Company have offices at 66 and 68 Broad street, New York City, and will cheerfully give information to those desiring it.

It is proposed to establish iron and steel works in Japan, and the Imperial Diet has approved of an appropriation of about a million sterling for that purpose. The estimated output of the works, which are likely to be in full working order in about three years' time, is 60,000 tons per annum; which total is to be gradually increased as the works develop. The product is to be divided into 35,000 tons of Bessemer, 20,000 tons of Siemens-Martin, 4,500 tons of wrought iron, and 500 tons of crucible steel. This enterprise is being undertaken with great deliberation, and there can be little doubt of its complete success. In the near future it is probable that Japan will not only be able to supply its own wants for iron and steel, but may have a superfluity that can be shipped to other countries.—*Industries.*

The Association of Superintendents of Bridges and Buildings will hold their annual convention in Chicago, on October 20, 21 and 22, and have made arrangements with the Leland Hotel, corner of Jackson street and Michigan avenue, for the accommodation of the members.

CONSTRUCTION AND MAINTENANCE OF RAILWAY CAR EQUIPMENT.

BY OSCAR ANTZ.

(Continued from page 105.)

FREIGHT TRUCKS.

One of the principal points in which American-built cars differ from those of other countries is in the manner of supporting the car-bodies on the wheels. On foreign cars the journal boxes on the axles usually work in pedestals or other contrivances attached rigidly to the car-body, thereby always keeping the centers of the axles at right angles with the center line of the car; the lost motion in the bearings and boxes and the sideplay of the wheels on the track are depended upon to allow the car to move around curves. On American-built cars the body is generally carried on two independent trucks, each of which is supported by two pairs of wheels and axles; the body is not rigidly connected to the trucks, but merely rests on them at their centers, leaving them free to adjust themselves to suit variations in the surface and line of the track.

The trucks are without doubt the most important part of a car when its safe running on the track is considered, and as certain parts of them are subjected to considerable wear, even in ordinary service, it is of the utmost importance to have these parts made so that they can be readily replaced whether on the home road or on foreign lines. This fact was recognized early in the existence of the M. C. B. Association and standards were prescribed for these parts, which have been adhered to more closely, perhaps, than any of the other M. C. B. standards.

WHEELS AND AXLES.

Naturally the wheels and axles received considerable attention. While it would hardly be policy to recommend an absolute standard for a wheel, still the diameter of 33 inches is now almost all over this country recognized as the proper size of a freight-car wheel; the shape of the tread or part which rests on the rail, the thickness and shape of the flange, as well as the location of the wheels when mounted on the axle, have been adopted as standards.

Freight-car wheels are usually made of cast iron of the so-called double-plate type, with a chilled tread, and specifications have been drawn up for these, which are recommended by the M. C. B. Association as good practice, as they are based on the results of many experiments and deductions obtained from practice. The usual weight of a cast wheel for cars of 60,000 pounds capacity is about 600 pounds. Wheels of other material than cast iron are used somewhat, but to no large extent in freight service—these wheels generally being provided with independent tires of steel.

Two sizes of axles have been adopted, one for cars of 40,000 to 50,000 pounds capacity, and one for those of 60,000 pounds. The length between centers of journals is the same in both, viz., 6 feet 3 inches; the size of the journal of the smaller one is 3½ inches diameter and 7 inches long, that of the larger one 4½ inches diameter and 8 inches long, the other parts of the axles being in proportion. The weights are about 400 pounds for the smaller one and 500 pounds for the larger.

Attempts have been made in recent years to increase the size of the smaller journal to 4 inches in diameter, but this change has not been officially adopted.

The sizes of an axle and other parts of the running gear for cars of 80,000 pounds capacity are at present under consideration by the association.

Axles are made of both wrought iron and steel and each metal has numerous advocates, and it would be presumptuous to say that either is the better metal. Steel of a good quality is perhaps the stronger and is less liable to have inherent defects in the shape of hard spots, seams, etc., but it is the experience of many roads that steel axles are more liable to heat and occasionally break without apparent cause.

JOURNAL BOX AND CONTAINED PARTS.

The journal box and contained parts, viz., journal bearing and

key, for both sizes of journal, and also the general outline of a journal box-lid which answers for both sizes of box, have been adopted as standards; as all of these parts, as well as the wheels and axles are published each year in the Proceedings of the M. C. B. Association, they will not be reproduced here.

RIGID TRUCKS.

The distinctive American truck is the diamond truck, so-called from the shape of the framework connecting the two journal boxes on the corresponding ends of the two axles of the truck. There are two of these frames connected together by a crossframe which supports the bolster on which the car-body rests. The bolster rests on top of springs which are either supported directly by the crossframe, thereby allowing no lateral motion of the bolster with respect to the truck frame, or else the springs rest on

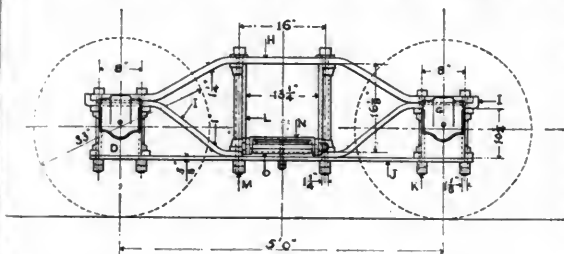


Fig. 39.

a platform which is suspended by hangers from the crossframe, and allows a certain amount of lateral motion of the bolster. This difference gives us two distinct styles of trucks, the so-called rigid and the swing-motion.

Rigid trucks are now almost universally used under heavy cars in this country, as their construction is stronger and their first cost and maintenance are less than with the swing motion style; a large part of the lighter cars also use this style of truck, of a lighter construction. Trucks of other than the diamond style have been under freight cars, and since the introduction of pressed steel in car construction several new types have been put on the market, which will be considered later.

Figs. 39, 40 and 41 represent a rigid diamond truck, which can be considered as a good example of modern practice, the bolsters and springs being omitted, as these will be shown by themselves.

The wheels *AA* are mounted by means of hydraulic pressure on the axles *BB*, the journals on the ends of these run in journal bearings *CC*, which are held in the journal boxes *DD* by the keys *EE*. The journal is lubricated by oil or grease held in suspension by wool or cotton waste, with which the lower part of the journal box is filled; wooden dust guards *FF*, which are inserted in a slot in the back of the box, and covers *GG* on the front prevent dust

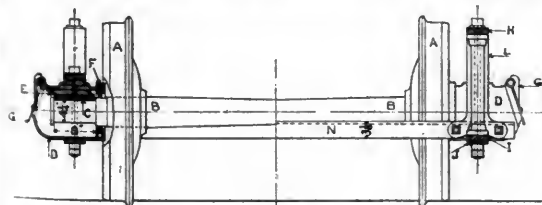


Fig. 41.

rising from the roadbed from entering the box and causing the journals to heat.

Connecting the journal boxes on each side of the truck are the archbars *HH*, the inverted archbars *II* and the tie bars *JJ*, all of which are secured to each box by two $\frac{1}{2}$ -inch journal box bolts *KK*. These bolts, as well as all the other bolts of the truck, should be provided with double nuts or some other means of securing the nuts against working off the bolts, which they are very liable to do on account of the constant jar. The in-

verted archbar is turned up at its ends, forming lugs against which the upper archbar is fitted. Archbars vary more or less in cross-section, and attempts to have them standardized by the Master Car Builders' Association have not been successful. The width of 4 inches is generally adopted for 60,000-pound cars, but the thicknesses vary; those shown can be considered good practice. The wheel base or distance between centers of axles is generally 5 feet or 5 feet 2 inches.

To obtain trucks of various heights from rail to center-plate, with as few changes as possible, such as would be desirable for the sake of adhering as nearly as possible to one standard, on a road having cars which vary in the vertical distance from center-plate to drawbar center, the offset of the archbars can be varied to suit these heights, the total distance at the center being always the same; and this can be done without making any other changes whatever. This is done to quite some extent in practice, there being cases in which the upper arch-bar is made entirely straight, and others where the tie-bar is arched up at the center.

Separating the upper and the inverted arch-bars near their centers are the two column guides *LL* which are secured to the arch-bars by the $\frac{1}{2}$ -inch column bolts *MM*, and to the spring plank by two $\frac{1}{2}$ -inch bolts passing through both columns and through the spring plank. Column bolts should be made with a fillet under the head, and to avoid counterboring the arch-bar for this fillet, which would weaken the bar, a thin malleable washer can be placed under the head with the space for the fillet cast in it. The column guides preserve the distance between the arch-bars and also act as guides for the truck bolster, and prevent it from moving laterally, leaving it free to move vertically.

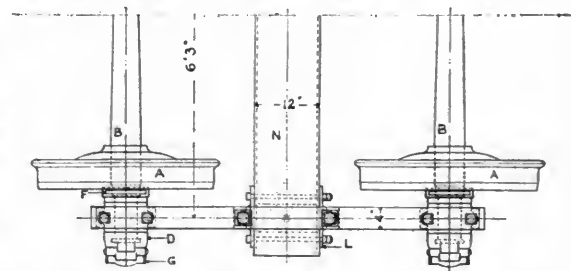
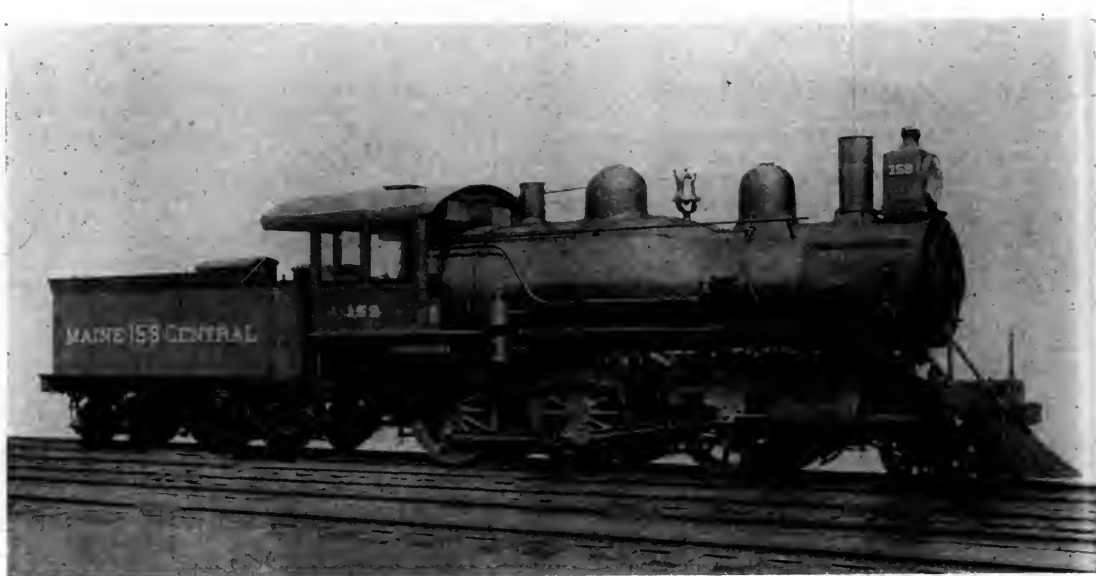


Fig. 40.

The spring plank *NN* connects the arch bars of the two sides of the truck and is bolted to the column guides by the two $\frac{1}{2}$ inch bolts mentioned and also to the lower arch and tie bars by one $\frac{1}{2}$ inch bolt, a casting *OO* being introduced to fill up the space between the flanges when a channel bar is used with the flanges turned down. The spring plank acts as the support for the bolster springs, and in the earlier cars was made of wood, hence its name. Spring planks are now usually made of channel bars, the one shown being 12 inches wide. There is no common custom in placing the bars, in regard to having the flanges up or down, both methods being practiced, and there is probably very little difference in the end. Spring planks have recently been made of pressed steel of the general shape of the channel bar.

The weight of the metal in the trucks of an ordinary freight car is far in excess of the weight of all the balance of the metal in the car, and attempts have been made of late to reduce this weight to some extent. This is accomplished by making the castings of malleable iron, instead of cast iron, whereby they can be lightened up probably one-half, and as the cost of malleable iron is about twice that of cast iron, the cost of the car is not materially increased. Pressed steel is also used somewhat for certain parts, whereby they can be tightened even more yet.

In the rotating tests of cylindrical shafts conducted at the Watertown Arsenal it is said that all steels as yet experimented with have failed under a fiber stress not exceeding 40,000 pounds per square inch, with a total number of repetitions of from four to seven millions for high steels.



Mogul Freight Locomotive With 20 by 26-Inch Cylinders—Maine Central Railroad.

Built by the Schenectady Locomotive Works.

Mogul Freight Locomotive for the Maine Central Railroad.

We are indebted to the Schenectady Locomotive Works for the photograph from which was made the accompanying engraving of one of the mogul engines recently built by the firm for the Maine Central Railroad. There were five of these engines in the order, and they were built to conform to specifications furnished by Mr. Amos Pillsbury, Superintendent of Motive Power of the road. The boiler is of the extended wagon-top type, and carries 190 pounds pressure. It has a large grate and ample heating surface, and is proving to be an excellent steamer. The engine has the full deck common to the ordinary eight-wheeled engine, thus securing a convenient arrangement of levers and valves in the cab—a matter which the men appreciate. The pistons have their rods extended through the front cylinder heads, a practice that is gaining in favor, as it is found that the saving in wear in the cylinders of large engines is considerable. The engines have 63 inch driving wheels, and 20 by 26-inch cylinders, proportions which will make a satisfactory and economical freight engine. The use of comparatively large drivers on freight engines is a move in the right direction.

From the specifications we take the following particulars:

General Dimensions.

Gage.....	4 feet 8½ inches
Fuel.....	Bituminous coal
Weight in working order.....	136,600 pounds
on drivers.....	117,600 pounds
Wheel base, driving.....	14 feet 6 inches
" " rigid.....	14 feet 6 inches
" " Total.....	22 feet 3 inches

Cylinders.

Diam. of cylinders.....	20 inches
Stroke of piston.....	26 inches
Diam. of piston rod.....	3¼ inches
Kind " " packing.....	Dunbar
rod packing.....	U. S. Metallic
Size of steam ports.....	18 inches by 1¼ inches
" " exhaust ".....	19 inches by 3 inches
" " bridges ".....	1¼ inches

Valves.

Kind of slide valves.....	Richardson balanced
Greatest travel of slide valves.....	5½ inches
Outside lap " ".....	¾ inches
Inside " ".....	1 inch
Lead of valves in full gear.....	1 inch
Kind of valve stem packing.....	U. S. Metallic

Wheels, Etc.

Diameter of driving wheels outside of tire.....	63 inches
---	-----------

Driving box material.....	Steeled cast iron
Diameter and length of driving journals.....	8¼ inches diameter by 11 inches
" " " " main crank pin journals.....	8 inches diameter by 6 inches
" " " " side rod crank pin journals.....	Main 6¼ inches diameter by 5¼ inches F. & B. 1¼ inches diameter by 3¼ inches.
Engine truck, kind.....	Two-wheel, swing bolster
Diameter of engine truck wheels.....	6 inches diameter by 10 inches
Kind " ".....	Krupp No. 3 wheel. Tire 3¼ inches by 5¼ inches, held by retaining rings.
Boiler.....	Extended wagon top
Outside diameter of first ring.....	62¼ inches
Working pressure.....	190 pounds
Material of barrel and outside of firebox.....	Carbon steel
Thickness of plates in barrel and outside of firebox.....	¾ inch, ¾ inch, ¾ inch, 1¼ inch and ¾ inch
Horizontal seams.....	Butt joint, sextuple riveted, with welt strip inside and outside.
Circumferential seams.....	Double riveted
Firebox, length.....	96¼ inches
" width.....	40½ inches
Firebox, material.....	Carbon steel
plates, thickness.....	Sides, ¾ inch; back, ¾ inch; crown, ¾ inch; tube sheet, ¾ inch
" " water space.....	Front, 4 inches; sides, 3¼ inches; back, 4 inches
" " crown staying.....	Radial stays, 1 inch diameter
staybolts.....	Taylor iron, ¾ inch and 1
Tubes, material.....	Charcoal iron, No. 12 W. G.
" number of.....	30
" diameter.....	3 inches
length over tube sheets.....	12 feet
Fire brick, supported on.....	Water tubes
Heating surface, tubes.....	1,996.61 square feet
" " water tubes.....	20.51
" " firebox.....	155.03
" " Total.....	2,172.18
Grate.....	25.96
" style.....	Rocking, with dump plates
Boiler supplied by.....	Two Hancock Inspiring, Type D., No. 9

Tender.

Weight, empty.....	37,800 pounds
Wheels, number of.....	8
" diameter.....	33 inches
Journals, diameter and length.....	4½ inches diameter by 8 inches
Wheel base.....	14 feet 8 inches
Tender frame.....	6¼ inches by 4 inches by ¾ inch angle iron
trucks.....	4-wheel, channel iron, M. C. style
Water capacity.....	4,000 U. S. gallons
Coal.....	8 (2,000 pounds) tons
Total wheel base of engine and tender.....	47 feet 7¼ inches
" length.....	56 feet 9½ inches

The engines are fitted with the Westinghouse-American brake on all drivers, tender and for train, two 3-inch Ashton safety valves—one muffled and one open pop, Asbestos cement boiler lagging, Trojan coupler on pilot and rear of tender, National Hollow Brake Beams, with Lappin flanged shoes, and No. 3 Crosby 6 inch Chime whistle.

The engines have been in service long enough to demonstrate that their operation is excellent and that they are very light on fuel.

Transmission and Application of Power to Machine Tools.*

The years 1866 to 1873 saw a large number of stationary riveters successfully introduced, and the success of the hydraulic system firmly established. Flanging and stamping presses and hydraulic shears were also introduced in considerable numbers during this period. In 1871 the portable riveter was designed and patented by the author. The manufacture of this entirely novel type of machine tool was, however, declined by several engineers, including those who had been so successful with his stationary machines, as visionary and impracticable. The author was at last fortunate enough to secure the co-operation of Mr. James Platt, a Lancashire engineer, established at Gloucester in partnership with Mr. Fielding. They undertook to make it. It is quite certain, however, that neither the author nor Mr. Platt had any idea of the troubles in store for them. The difficulties were not so much due to its special hydraulic features as to the difficulty at that time in obtaining suitable steel for the arms, getting sufficient rigidity, combined with lightness, and arranging all the various connections to lead the water from the accumulator to the portable riveters suspended many feet in mid-air. However, in 1873, the Primrose Street Bridge, over the Great Eastern Railway, London, was completed, being the first bridge mechanically riveted *in situ*. Just as most of the initial difficulties were surmounted Mr. Fielding died, and in the many new designs and applications introduced and patented since then, his son, Mr. John Fielding, has been closely identified.

But if 1873 was an important epoch in hydraulic riveting, the year 1878 afforded the first opportunity of fully showing the economical advantage of the hydraulic system as a means of transmitting power to machines of many different kinds spread out over great distances. In consequence of the author's representation, and the assistance of his colleague, Mr. Henry Chapman, of Paris, Mons. Marc Berrier-Fontaine, the engineer of the French arsenal at Toulon, authorized the laying out of the whole of their new works on the author's hydraulic system; the machinery being supplied by the Hydraulic Engineering Company, of Chester, and Messrs. Fielding & Platt, of Gloucester, and from that time the hydraulic system of machine tools was firmly established, and occupies in its proper field an unassailable position by reason of its economy and convenience of application.

There were two causes some 25 or 30 years ago which assisted the introduction of the hydraulic system for special classes of machine tools—first, the increasing size and scantling of all boilers, bridge and ship work, and second, the increased areas thereby covered by the works themselves. So long as hydraulic power is confined to work of a more or less reciprocating character (with the one exception of capstans), there is no other system comparable with it on the score of economy, but when we come to driving lathes, planers, spread over large areas, electrical power comes in on the ground of the convenient way in which it can be transmitted over great distances, and the suitability of its motors for rotary work. Always bearing in mind that their suitability for the work to be done is ascertained, it may be stated that for transmitting and applying power over great distances, water and electricity have both their special advantages. Electric transmission, if more costly, is on the other hand very conveniently applied at different points; travelling cranes may be cited as one of the best applications.

So far as the relative economy of hydraulic power, shafts and belting or electricity are comparable, it is easier to compare shafting with electricity than either of these with hydraulic power. In the case of the former, given an equally economical and efficient prime mover, for all reasonable distances, it resolves itself into a question of the interest on cost of shafting only, or on that of dynamo, with its leads, motors and shafting. When the distances become greater we can then compare the relative cost and advantages of hydraulic and electrical transmission. In many cases even this comparison is not possible, for the operation to be performed by the hydraulic machines and those driven by electricity are in many cases essentially different. Many of the heaviest operations done by hydraulic tools only occupy so short a time that a large reserve of power must be stored up to render them practicable. For reasons of cost this is not possible with electricity, but in the hydraulic system, perhaps, the most important feature is the accumulator, and it constitutes the most important factor in its economical success. We may at once eliminate this feature in an electric system on account of its present great cost, and, of course, in transmitting power by shafting or ropes it is also impossible; and

it can only be adopted to a limited extent in pneumatic transmission.

In the case of transmission by shafting or electricity, the prime mover must be large enough to meet such demands when they occur, but in the hydraulic system, not only is the prime mover not required to be equal to the greatest efforts (only occasionally required), but on the other hand the size of the prime mover can be very much reduced; for the accumulator allows of the smaller engine being kept more or less continuously running and storing up power during the very considerable intervals when only a portion of the machines are at work.

This question of the proportion of machines absolutely engaged "tooling" and those standing idle while work is being taken to or from them, or from other causes, is not a new one. The author alluded to this in a paper read by him in 1886, and gave some figures based on data published by Mr. William Hartnell. It may not be amiss to draw attention to the very considerable mechanical, if only occasional, work done in hydraulic machine tools with prime movers of almost plimpy proportions. In our youthful days the raising of the Conway Bridge tubes was always cited as an instance of a great effort. Well, the best they did was lifting 1,300 tons 13 feet in 60 minutes, or 282 foot-tons per minute. The ordinary 150 tons riveting machine will make four strokes per minute of 6-inch each = 300 foot-tons per minute, but the mechanical effort is really more, for these two feet are really done in little over 20 seconds, the remaining 40 seconds being required for the return stroke of the ram. If such a machine had to be driven by shafting or electricity, in the first instance the prime mover must be equal to exerting this 300 tons in 20 seconds plus friction of shifting; and in the case of electric transmission the prime mover must be the same plus the losses incidental to the dynamo, the cables and the electric motor gearing between it and the machine. We will leave it to others to minimize or fix these losses, but we know that in the case of pumps and accumulators and mains, which we may take as occupying the same place as the dynamo, leads and electric motor, that the loss is extremely small.

The efficiency of good pumps is 78 per cent., that of the accumulator 91 per cent., and the loss in properly designed mains is extremely small.

Coming now to the machine tools to be worked by the water thus transmitted: It is, of course, understood that generally speaking we are only discussing, this evening, machines suitable for hydraulic pressure, either by reason of their being required to exert a great force during a short period, or to exert in addition more numerous efforts (such as punching, shearing or riveting) at distances from the prime mover beyond the reach of shafting.

In the former case we have shown that the hydraulic system alone meets the case, and for great efforts, such as forging, flanging, etc., the same applies. But in smaller machines there is more room for divergent opinions.

This brings us to the consideration of the suitability of hydraulic pressure for punching and similar machinery, placed about large ship and bridge yards. We have lately seen some startling instances, from an electrical standpoint, of the wastefulness of this class of machine driven by separate steam engines, all of which was pointed out by the author 24 years ago, in many technical journals and papers, with the view of substituting hydraulic machines.

Electricity as a motive power for moderate sized machines in frequent work certainly seems to fulfil most of the conditions, but it cannot claim to have all its own way. The machine has to wait till the speed of the motor is got up, and a similar loss of time and power ensues when the machine is being stopped, whereas in the hydraulic machine it is only consuming power while work is being done. There are, of course, losses peculiar to the hydraulic system, and there are climatic considerations to be considered, and the final verdict as to the power selected can only be the result of experience and judgment brought to bear on each particular case.

In many classes of work it is essential that the exact pressure exerted be known, and that the same pressure be exerted every time it is applied under similar conditions. This is the case more especially in riveting. In the case of riveting, as is well known, the length of rivets, when finally closed, is more or less a varying one, owing to the temperature, number of thicknesses of plates, etc. The hydraulic ram can be made of sufficient stroke to do the shortest or the longest, and at the end in every case exert the same final pressure. We have in this a very important advantage—only obtainable in hydraulic machines. This range of travel is one of the chief advantages of all hydraulic machines, and is practically unobtainable in geared machines, whether driven by shafting or electric motors.

* Part of a paper written by the late M. R. H. Tweddell and read January 25, 1896, before the Manchester Association of Engineers.

(Established 1832.)

AMERICAN ENGINEER CAR BUILDER and RAILROAD JOURNAL.

27TH YEAR.

65TH YEAR.

PUBLISHED MONTHLY

BY
R. M. VAN ARSDALE,

MORSE BUILDING.....NEW YORK.

M. N. FORNEY,
W. H. MARSHALL, } Editors.

R. G. CHASE, 705 Western Union Building, Chicago.

SEPTEMBER, 1896.

Subscription.—\$2.00 a year for the United States and Canada; \$2.50 a year to Foreign Countries embraced in the Universal Postal Union.

EDITORIAL ANNOUNCEMENTS.

Advertisements.—Nothing will be inserted in this journal for pay, EXCEPT IN THE ADVERTISING PAGES. The reading pages will contain only such matter as we consider of interest to our readers.

Special Notice.—As the AMERICAN ENGINEER, CAR BUILDER AND RAILROAD JOURNAL is printed and ready for mailing on the last day of the month, correspondence, advertisements, etc., intended for insertion must be received not later than the 25th day of each month.

Contributions.—Articles relating to railway rolling stock construction and management and kindred topics, by those who are practically acquainted with these subjects, are specially desired. Also early notices of official changes, and additions of new equipment for the road or the shop, by purchase or construction.

To Subscribers.—The AMERICAN ENGINEER, CAR BUILDER AND RAILROAD JOURNAL is mailed regularly to every subscriber each month. Any subscriber who fails to receive his paper ought at once to notify the postmaster at the office of delivery, and in case the paper is not then obtained this office should be notified, so that the missing paper may be supplied. When a subscriber changes his address he ought to notify this office at once, so that the paper may be sent to the proper destination.

The paper may be obtained and subscriptions for it sent to the following agencies: **Chicago**, Post Office News Co., 217 Dearborn Street. **London, Eng.**, Sampson Low, Marston & Co., Limited St. Dunstan's House, Fetter Lane, E. C.

CONTENTS.

ILLUSTRATED ARTICLES:	Page
Altoona Shops of Pennsylvania Railroad.....	203
Indicator Hugging for Locomotives.....	206
Forty-Six-Foot Furnace Car, C. & M. & St. P. Railway.....	209
Pittsburgh Compound Locomotive for the Lake Superior & Ishpeming Railway.....	211
Construction and Maintenance of Railway Car Equipment.....	216
Freight Locomotive—Maine Central Railroad.....	218
Report on Fire-Proofing Tests.....	228
The Most Advantageous Dimensions for Locomotive Exhaust Pipes and Smokestacks.....	231
Water-Tube Boilers.....	235
Double-Cylinder Boring Machine.....	237
The Wagner 12-inch Lathe.....	238
The Fader Dump Car.....	238
EDITORIALS:	
"R. R. B." Mail.....	220
Early Use of Compressed Air in Railroad Shops.....	220
An Air Compressor That is a Failure.....	220
Need of More Engineer Officers in the Navy.....	221
Horse Power Consumed by Shafting.....	221
Economy of Large Drivers for Locomotives.....	221

EDITORIALS:	Page
Thermal Tests of Car Wheels.....	221
Defects and Improvements in Locomotives.....	222
Railroads Should Pay More Attention to Their Stationary Plants.....	224
MISCELLANEOUS:	
Sensational Tests of Car Wheels.....	206
Subjects and Committees of the Air Brake Men's Association.....	211
Contributions to Practical Railroad Information.....	212
Mill Heating from the Hot Well.....	214
Freight Car Repair Shops of the Southern Pacific at Sacramento.....	214
Mileage of Chilled Cast-Iron Wheels in Freight Service.....	215
Convention of Master Car and Locomotive Painters' Association.....	215
Introduction of our Engineering Practice into the South American Republics.....	215
Transmission and Application of Power to Machine Tools.....	219
Engineering Notes.....	224
Personals.....	227
Equipment Notes.....	227
New Publications.....	231
A New Dynamometer.....	237
Manufacturing Notes.....	239
Our Directory.....	240

The notification by the Postmaster-General that the law would be enforced forbidding the transportation of letters or other written papers on railroad trains unless postage is paid on them, was a knockout-out blow at the "R. R. B." letters. The action of the railroads under the notification has not been uniform. Some have abandoned "R. R. B." mail entirely, while a number of large companies have issued orders that the correspondence sent by "R. R. B." mail shall only be such as pertains to the business of the company and destined to points on its road. In other words they hold by this action that the exchange of railway mail between railroads may be rightfully stopped by the postal authorities, but that their right to transport their own letters in their own cars to points on their own line cannot be taken from them, the law to the contrary notwithstanding. The law as it stands appears to be with the Postmaster-General, but if pressed far enough it is believed that it would be declared unconstitutional, in-so-far as it prevents railways carrying their own mail between points on their own lines.

The use of compressed air in railroad shops, which has made such progress of late, did not originate in recent years. We are informed that in 1879 the first air motor to be used in the Missouri Pacific shops was made and put in operation in the St. Louis shops of that road. It is claimed that this was the first railroad shop to use compressed air in running small tools and doing other work which otherwise had been done by belt-driven machinery. As early as December, 1882, there appeared in the NATIONAL CAR BUILDER, an article on these shops in which the following reference was made to the use of compressed air: "These shops have in use a portable drilling machine driven by a three-cylinder Brotherhood engine supplied with air from two Westinghouse pumps. These engines are quite small, are mounted on wheels, and are also used for driving staybolt taps, portable cylinder-boring machine and valve-facing machine. They were designed by Mr. Hewitt, the superintendent of machinery, aided by his assistant, Mr. Leroy Bartlett. Inasmuch as they can be taken to any place in the shop and applied to almost any kind of work, taking the place of handwork in many cases, it is a little surprising that such machines are not more generally used." Thus, as far back as 1882, we find the advantages of compressed air clearly stated and the practice of one road cited in a way that shows its officials had applied it to many of the uses to which it is now put. Why others should have been so slow to take it up is not clear, but whatever the reason the rate at which it has been adopted in the last few years shows that at present it is appreciated.

A contemporary publishes in a recent issue a description of an air compressor being built at Bridgeport by a company whose object seems to be much the same as that in view by the free silverites in the present political campaign—they want to get something for nothing. They are persuading themselves that a 140 horse-power steam engine will turn an 82-foot wheel and develop 2,500 horse-power at the rim. The 82-foot wheel carries ten groups of wheels, three in a group, each wheel weighing 4½ tons. These wheels, as the large one revolves, operate cam levers connected with the pistons of 100 compound air compressors with 16-inch by 12-inch intake cylinders, secured to a fixed circular track under the wheel. The mechanism thus consists of 204 pistons, one 82-foot wheel, thirty 9-foot wheels, 50 cam levers, numerous gears, etc., etc., while eight single compound compressors with 32-inch by 36-inch cylinders would compress a like amount of air. But this extra mechanism is as nothing compared with the power to be created by it, which is 2,500 — 140 = 2,360 horse power, which, if worth \$30 per year per horse-power, amounts to \$70,800 per annum. This, you see, is clear gain. But why don't the promoters dispense with the machinery and use the 140 horse-power engine alone? All they need do is pronounce its output to be 2,500 horse power instead of 140 horse power, and then rake in the \$70,800 per year. That is what we are asked to do with the silver dollar—just announce that its 53 cents are not 53 cents but exactly 100 cents, and lo! it

will be so. The simplicity of such a proceeding makes it far superior to using hundreds of tons of machinery to raise 140 horse-power to 2,500 horse-power.

The illness of two of the engineer officers of the United States battleship *Indiana*, Chief Engineer George E. Tower and Passed Assistant Engineer A. McAllister, during the manœuvres of the Atlantic squadron last month, is a forceful illustration of the need of an increase in the engineering branch of the navy. The modern battleship is an immense aggregation of machinery—machinery everywhere and for everything, and that the large amount of skilled labor and of mental energy necessary to keep it in good condition at all times, is not realized or is deliberately ignored and the lives of officers thereby jeopardized, is a disgrace. The cruiser *Columbia*, with 90 engines, 172 steam cylinders, and all its varied and complicated machinery, has only four engineers. Is it any wonder the engineers are unable to stand the strain? There are to-day four line officers to one engineer in the navy, and yet the line officers are actively opposing any increase in numbers or authority of the engineers. And so after eight days of peaceful manœuvring the efficiency of the most powerful battleship of the navy is for the time impaired by the temporary loss of one-half of its engineering staff. What would be the condition of affairs in case of war if peace manœuvres are so disastrous? Who is going to assume the responsibility for this condition of affairs? It is to be feared that when the citizens of this nation finally awakened to a realization of what is going on they will refuse to believe that anything approaching patriotism and the good of the service has been the actuating motive of line officers, and these officials will then lose more of their prestige than if they now used their influence to promote needed reforms. The more the pendulum is held to one side of the normal the further it will go to the other side when once it is liberated.

The economy in the direct application of the power of a steam engine to the work to be done is generally conceded, and the magnitude of the saving thereby effected is well illustrated by the power required for driving the "jack shafts," so common in electric installations a few years ago. In the power station of the Elmira Illuminating Company, of Elmira, New York, there is a jack shaft 136 feet long by $5\frac{1}{2}$ and $6\frac{1}{2}$ inches in diameter. To this shaft are belted five steam engines, three of which are of 300 horse power each, and one of 500 horse power, and a number of dynamos, the shaft having 20-clutch couplings, so as to use any desired combination of engines and dynamos. The horse power required to drive this shaft was 83.2, and in a recent test of the 500 horse-power engine recorded in a paper before the American Society of Mechanical Engineers, the percentage of the total engine power consumed by this shaft varied from 16.6 per cent. under a full engine load to from 30 to 45 per cent. under the light loads. This indicates one of the advantages obtained in the direct connected engines and dynamos now almost universally installed in such stations, and is also suggestive of the economies which can be obtained by a judicious rearrangement of line shafting in shops, by which much of it will be dispensed with and the tools driven singly or in groups by electric motors.

A contemporary in giving the general results of the tests which a certain railroad is making with the simple and compound mogul engines built at its shops, states correctly that the various kinds of compounds do not differ much from each other in economy, and average about 15 per cent. less coal than the simple moguls. It then makes the statement that these compounds compared with a class of consolidations pull 15 per cent. more load and do the work on less than half the fuel. This is one of those sweeping statements that won't bear investigation. To illustrate: If we take "less than half the fuel" at 45 per cent. and do 15 per cent. more work with it, the result is the same as if the same amount of work had been done with 39 per cent. of the fuel used by the consolidation engines. Now, either the compounds are marvels, the consolidations of shockingly bad design, or the statement of performance untrue. The probability is that

the trouble is with the statement. A large saving ought to be expected from three causes—the compounding, the use of relatively large drivers and the elimination of one pair of drivers, but as the compounding is only credited with 15 per cent., railroad men will be slow to believe that 46 per cent. saving is obtainable by using a mogul with 62-inch drivers in place of a consolidation engine with much smaller wheels. And yet, while the magnitude of the saving may not be as much as is claimed in such careless statements, the experience of the last few years is leading to better and more economical designs of freight engines. Large drivers were in disfavor for years because they were usually accompanied by small cylinders, and the combination did not succeed in producing the required tractive effort. Three and four pairs of driving wheels with moderate weights on them were used because track and bridges would not permit of heavy weights per wheel and because it was feared that tires and rail heads could not endure heavier loads without rapid flow of the metal and consequent destruction to both. Now we know better and the conditions on many roads have changed. Loads as high as 46,000 pounds per pair of wheels are believed to cause no damage to large tires or to heavy rails, and modern track and bridges are considered safe under such loads. Consequently, with the higher wheel loads permissible, a weight formerly put on four pair of wheels can now be carried on three pairs, and the weight that used to be the maximum for three pairs is now readily carried on two. The internal friction of the engine and the number of moving parts is thus reduced, with economy as the result. The higher steam pressures and larger boilers and cylinders now used in combination with relatively large drivers for freight engines, have made the large drivers a success. Their use has likewise resulted in economy through reduced piston speed and less friction, and the smaller cost of repairs. That these facts are realized by the mechanical departments of railroads is evident from the present tendency toward larger drivers and fewer of them for freight engines, the consolidation type when used being justified by a great weight on the drivers. But while the saving in wear and tear and in fuel justify these reforms, the fuel saving cannot reach 46 per cent., for the simple reason that the total loss from these causes was not that much.

THERMAL TESTS OF CAR WHEELS.

A correspondent, who modestly asks that his name be not used in connection therewith, has sent us an account of some interesting tests which he made of car wheels, after reading the article in our June number describing the experiments which were made in Altoona. The heat he says which was applied by the tests was in excess of anything possible from the application of brakes. A band of molten metal $1\frac{1}{4}$ inches thick by 4 inches

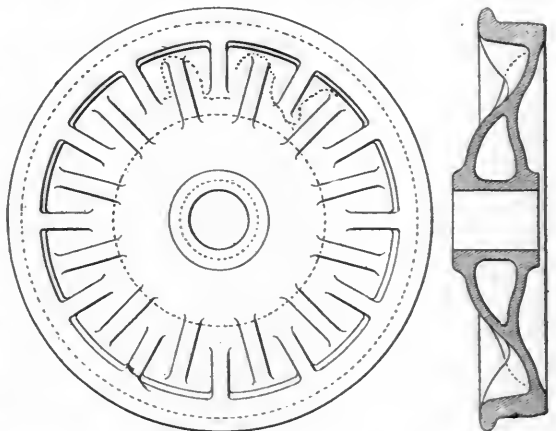


Fig. 1.

Fig. 2.

deep was poured around the rims as in the Albina tests. If the wheels were removed at once, as soon as the molten metal was set, the plates or brackets would not crack, but if allowed to remain any length of time they would. The wheels were 33 inches in diameter of what is called the double-plate pattern shown in Figs. 1 and 2. The brackets or ribs on the back of the wheel were arranged as shown in Fig. 1; that is, each alternate bracket extended from the rim inward, and those between extended from the inner plate outward as shown in Fig. 2. The object of this arrangement is to relieve the strains from contraction after the wheel is cast, and it is also thought that with ribs arranged

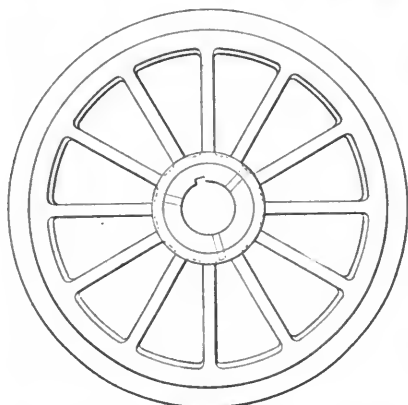


Fig. 3.



Fig. 4.

in this way wheels have greater strength to resist the strains to which they are subjected in service.

In the tests which were made this form of wheel did not crack until two minutes after the metal was poured around it, and, as has been stated, if they were removed from the band of molten metal immediately after it was poured, neither the plates nor the ribs were broken. The form of the crack was peculiar, and is represented by the dotted line in Fig. 1, and, as will be seen, it did not extend across any of the ribs or the rim, the plate only being fractured. In such tests, it is said, the rims are heated to a much higher temperature than is possible by the application of the brakes. While the wheels with the brackets arranged, as



shown, did not crack until the rims had been subjected for a considerable time (two minutes) to continuous heat, wheels of the usual "Washburn" pattern cracked almost instantly after the metal was poured around the rim, the fractures occurring through both the ribs and rim, which indicates, as was intimated in the article referred to, that the form of the wheel has

an important influence in its capacity to resist such strains, and also that the ordinary "Washburn" pattern is not the best form.

In our article in the June issue on this subject we illustrated by an engraving made from memory a form of cast-iron wheel, which was made by Ross Winans 40 or 50 years ago, and we ventured the observation that it seemed as though a wheel made in that way would not be broken if tested in the manner described. Fortunately the experimenter who made the tests, which are the subject of this article, had one of these wheels which was made by Winans in 1840, of "Connervingo" charcoal iron, and he has sent us a drawing of it, from which Figs. 3 and 4 have been made. This wheel is 30 inches in diameter, weighs 400 pounds, and the hub was made in three parts which had slots or spaces between them which were filled with zinc. The hub was then banded on both sides with wrought-iron rings, which were shrunk on, as shown. There is also a wrought-iron ring shown in Fig. 4, and which was described in our article published in June. This ring was made of round wrought iron, $\frac{1}{2}$ inch in diameter, and was cast in the wheels inside of the throat of the flange. The wheel referred to was subjected to the molten iron test, as described, without cracking. It took a minute for that to extend to the hub and two minutes to equalize through the parts of the wheel.

Experiments were also made with an ordinary open-motor-face truck wheel, Fig. 5, by placing a red-hot chill ring or band around the rim. It was allowed to remain on the wheel until it became cool (55 minutes), all the heat, excepting that which was radiated from the outside of the ring, being absorbed by the wheel casting, which was so hot at the expiration of that time that it was uncomfortable to bear the hand on it. The wheel stood the test without cracking or showing any signs of injury.

It will thus be seen that in these experiments the two spoke wheels stood the thermal test without breaking, which is additional testimony to the fact, which was suggested in the article referred to, that the capacity of cast-iron wheels to resist such tests as have been described depends very much upon the form of the wheel, which opens up the interesting inquiry, what is the best form for such wheels?

The experiments here described have great interest in the consideration of a reply to this inquiry. If it is true that spoke wheels are less liable to break than plate wheels it is an important fact and one which it would be worth while to prove by experiment.

DEFECTS AND IMPROVEMENTS IN LOCOMOTIVES.

Notwithstanding the wonderful development of the locomotive and what it has accomplished for civilization and the welfare of mankind it must be admitted that it still has many defects, and some of us are still sanguine enough to think that it is susceptible of further improvement.

It may be said, for example, that a pound of average coal contains sufficient potential heat to evaporate about 12½ pounds of water. It will not be far out of the way to say that in ordinary practice the average evaporation is not more than half that amount of water per pound of coal, so that half of its heat escapes out of the chimney, or falls through the grate unutilized, or goes to waste. This waste is due partly to imperfect combustion, and partly because the heat in the products of combustion is not communicated to the water in the boiler. It is not uncommon to find a temperature of 800 degrees or more in the smokebox of a locomotive, and as the temperature of steam of 150 pounds pressure per square inch is only 366 degrees obviously these escaping gases have a capacity for generating a great deal of steam. Besides this the exhaust steam escapes at a pressure of about 15 pounds, and carries with it a great deal of heat which does no work. This is not a new view of the wastefulness of locomotive engines. The subject of improved combustion has been under consideration ever since locomotives and steam engines have been used, and the literature of the subject is now quite beyond the hope of mastering by any one person. Experiments innumerable and inventions which cannot be counted have been made to produce more economical results in the use of coal, but it must be admitted that

the progress which is made is very slow, and the saving which is effected is very slight. One of the main lines of road during the past year or two has been equipped with appliances for weighing fuel, and since then the subject has been studied more carefully on that road than ever before, with the result that a very important saving of coal has been effected, but after years of experience and investigation the verdict of the superintendent of motive power of that line, who has had a long experience in his calling, is that the best means for reducing the consumption of fuel is to improve the firemen. This he has done by having accurate reports of what each of them is doing, and then calling them to account when an excessive amount of coal is burned and investigating whether they or the engines are the cause of it. The breeding and education of firemen will not be discussed now, but the possibility and means of effecting economy by changes and modifications of the engines themselves will be considered.

We have recently made some inquiry with reference to the form and proportions of grates, having a vague idea that some grates are probably better than others. Thus far we have obtained but little more information than that contained in the general statement that grates should be adapted to the fuel to be burned on them. One investigator on the subject stated the general principle that "in every case the widest possible opening should be used that would hold the fuel." For burning shavings and wood, he recommended spaces between the bars $\frac{1}{2}$ inch wide; for "egg" and "furnace" anthracite and coke, $\frac{1}{2}$ -inch spaces; for bituminous coal, $\frac{3}{4}$ -inch; for sawdust and "nut" anthracite, $\frac{1}{2}$ -inch; for "pea" coal, $\frac{3}{4}$ -inch. In these recommendations authorities did not agree, and the conclusions seemed to be based on the most casual observations, and were not the result of any carefully made investigation or experiments. To such inquiries as we have made, the general reply of the average master mechanic, it is believed, would be only that general statement—that grates should be adapted to the fuel to be burned in them; but when it comes to any specific statements, with reference to the adaptation, our investigations have shown that their opinions are very vague.

Now, there can be no doubt that the intimate contact of air with the fuel promotes combustion, until, as in the case of powdered fuel and coal dust, when mixed with air they burn so rapidly as to become explosives. If the lumps of coal on a fire are too large, combustion is slow and imperfect, and this is also the case if it is fine and closely packed in the grate, as then the air comes in contact with only a small portion of the surface of the fuel. If coal is pulverized into dust, and floats or is blown in a current of air, the latter comes into such intimate contact with the particles of the fuel as to make it burn, as has been said, with the rapidity of an explosion. Between these limits there is almost every degree of perfect and imperfect combustion. As every fireman who understands his business knows, if coal is broken into suitable sized lumps it can be burned much more perfectly than is possible if it is either larger or smaller. It would seem, then, that what should be aimed at in a grate is to give the air access and bring it in contact with the fuel. That grates as at present made are the best which could be adopted for effecting that end seems very doubtful. It seems quite possible to design a grate which would permit air to circulate more freely below and among the fuel than it can as these appliances are now made. At present the top surfaces of grates are made to coincide with a plane flat surface. If instead of being flat this surface were made with projections so as to have interstices below the coal for the circulation of air it would seem as though it would do something to promote combustion.

Notwithstanding the fact that the value of dead plates has often been pointed out, most locomotive grates are still made without them. Attention has been called in these pages heretofore to the fact that it is desirable in all furnaces to keep the flame out of contact with the sides and top, until the process of combustion is completed. It seems quite certain that combustion is retarded and partially arrested when flame comes in contact with any solid substance. The inference from this, therefore, would appear to be that it is desirable to keep the fire away from the sides and ends of a firebox as much as possible, which may be

done by putting dead plates all around the grate so that no air will be admitted next to the sides and ends. The question of the most advantageous locality and proportions for dead plates is still a matter about which very little is known.

The most economical rate of combustion is also worthy of consideration. It probably may be either too slow or too rapid for economy, and it seems reasonable to infer that there is some rate which is more economical—at least, under given conditions—than any other. What this rate is we do not know, but as the amount of coal which must be burned in a locomotive firebox varies constantly, it would seem as though an essential for securing the highest economy would be a variable grate, or one in which the opening could be increased or diminished or in which the live and dead portions can be varied at pleasure. With such an appliance, the rate of combustion per square foot of grate could be kept uniform, or nearly so, in all conditions of working, and at the most economical rate.

In stationary boilers down-draft grates have met with a considerable degree of success. Whether they would be equally so in locomotives is of course an open question. The principle on which they operate seems to be a correct one, and there is no apparent reason why it is not applicable to locomotives as well as to stationary service.

It is, of course, true that while it is often possible to gain what is an apparent advantage, yet before it is ultimately realized it is offset by some expense or difficulty which entirely neutralizes the gain. In all such cases it is the algebraic sum alone which counts ultimately. If the + and the — quantities are equal, no matter how promising the former may be, they will be obliterated by the latter.

The attempts which have been made to save some of the heat which escapes up the chimneys of locomotives are in number almost like the efforts to achieve perpetual motion. They have generally been some form of feed-water heaters or steam superheaters. Nothing seems more plausible than a feed-water heater, and the theoretical advantages of superheating have been often shown. Nevertheless, after almost innumerable trials they have all been abandoned. The various considerations always overbalanced those with a + sign. Still, neither of them now seems to be entirely hopeless, even after a vast number of failures. It must always be kept in mind when improvements in locomotives are contemplated that they must be regarded somewhat as a farmer does a reaping machine. This must be ready and capable of cutting the harvest when it is ripe, and above all things must not break down before the work is completed. It is very much so with locomotives. There are periods of harvest time on railroads when it is of the utmost importance that freight and passenger trains should be moved. A breakdown when there is a congestion of traffic is a very serious matter. It does not make much difference how economical a locomotive may be or how well it works when it is in good condition, if it fails at the time when it is most needed, the cause of the failure, no matter whether it is or is not productive of economy, will be condemned. Feed-water heaters have come under this kind of condemnation. It is easy to prove that they will save fuel, but they are apt to prove costly in other ways. The problem is to secure their advantages without incurring the risks referred to. This it is thought might be done if the tubes of a locomotive were somewhat lengthened and their front ends were surrounded with cold feed-water. The escaping gases would thus impart more or less of the heat to the water surrounding the tubes. Now, to carry out this plan, suppose the boiler and the tubes were lengthened about two or three feet and that a plate or diaphragm, similar to a tube plate, was placed in the boiler about two feet back of the front ends of the tubes. The plate should extend upward to about the water line. If now the feed-water was delivered into the space between this diaphragm and the front tube sheet the cold water would be in contact with the front ends of the tubes and therefore more of the heat in that portion of the tubes would be imparted to the water than would be the case if the water outside of them were hot. The front ends of the tubes would thus act as a feed-water heater and there

would be no portion of it more liable to fail than the present boiler is. In other words, it would provide a feed-water heater without any of the objections which experience has shown have always attended the use of those which have heretofore been tried.

But the length of an article makes it impracticable to discuss some other features in locomotive construction which seem to be capable of improvement. The consideration of them will be reserved for a future article.

When we consider that the stationary steam plants owned and operated by railroads aggregate hundreds of thousands of horsepower, it is a matter of surprise that the members of the Master Mechanics' Association do not find some subjects in connection with them that would be worthy of discussion at its conventions. From the absence of such topics from the proceedings of the association it might be concluded that railroads believe there are no unsolved problems in connection with their stationary boiler plants and that their practice was up to date in every respect. And yet we have heard it said that there is a chance for great improvement in these very plants, and that the absence of discussion regarding them is only an indication of the indifference with which they are regarded. There may be a great deal of truth in this view of the case. Certain it is that many roads have stationary plants of such large dimensions that the types of boilers installed, the use of automatic stokers, conveyors for coal and ashes, methods of boiler setting, feed-water heaters and other kindred subjects are of considerable importance, and involve economies of no small magnitude. The mechanical department of a railway is, or should be, interested in more than locomotive practice, and a representative association of this class of men might profitably devote some attention to the economies obtainable either by better engines, boilers and appurtenances, or by improved methods of operating the present installations.

NOTES.

The engines of the *St. Paul*, on her recent record-breaking trip, developed a horse-power of slightly more than $1\frac{1}{2}$ pounds of coal—a most excellent performance, when it is considered that it is an average for an entire trip, during which the engines and boilers were worked hard. The daily consumption of coal was 315 tons.

A French journal publishes drawings of a new method of staying the fireboxes of locomotive boilers. The bolts, instead of passing through the inner sheets, enter part way only, the sheets being thickened at the bolts by small bosses on the water side of the sheet, so as to get sufficient thread to hold the sheet. Such a construction might be possible with copper sheets, but would be of little practical value, while with steel sheets it is next to impossible.

In addition to the tests of four different two cylinder compound mogul engines, the Pennsylvania Railroad has also been measuring lately the coal and water used by Class L passenger engines and the eight-wheeled two-cylinder compound passenger built at Altoona some time ago. The compound is using considerably less fuel than other engines on the same runs. It will be remembered that this engine has $19\frac{1}{2}$ and 31×28 -inch cylinders and 12-inch piston valves.

The Holman locomotive, that marvelous engine having a pyramid of multiplying wheels between each driver and the rail, being in principle an inverted Fontaine engine, recently hauled a train of two cars at speeds between 60 and 90 miles per hour. There is nothing remarkable about this speed, except the fact that the Holman locomotive made it. The wonder is that it could make the 20 small wheels placed under the drivers spin around at this speed. We have not heard of a saving of coal from the use of the 20 additional wheels and don't expect that any will be found.

In a paper on the design and manufacture of gears, read by S. Groves, M. E., before the Engineers' Society of Western Pennsyl-

vania, the general advantages of short gear teeth are given. The author says that in calculating the horse power of a gear the teeth are usually considered as cantilevers, liable to be broken off at their roots by lever strains. The new departure consists in so proportioning the teeth that the old lever strain was transformed into a shearing strain. To do this the length of the tooth was reduced from .7 to .5 of the pitch, and the flanks so shaped that but one tooth was in contact at a time. These gears are found to run noiselessly and are claimed to have great advantages for large powers and service in which severe shocks are encountered.

At Ashtabula Messrs. M. A. Hanna & Company have recently put in service a coaling barge for placing fuel upon steamers while they are unloading or receiving a cargo. The hull resembles that of a big scow, is 180 feet long, 36 feet beam and contains 16 compartments capable of holding 640 tons of coal. At one end is a small set of engines for the twin screws, by which the barge is propelled about the harbor. At the other end are elevators for lifting the coal from the barge to the steamers. Under the pockets or compartments is a conveyor that delivers the coal to the boot of the elevator. The barge can approach a steamer at the dock from the harbor side and deliver the coal quickly and without interfering with the handling of the cargo.

Trial runs were lately made in Germany, between Berlin and Lubbenau on the Berlin and Gorlitz line. A German contemporary says that for these runs a special express engine of new design with four cylinders and driving wheels of two meters (6 feet 6 inches) diameter was constructed. The trains were of various lengths, amounting sometimes to 100 axles. With a train of 30 axles the highest performance, viz., 106 kilometers (65½ miles) per hour, was recorded, being 20 kilometers (12 miles) more than the highest speed hitherto attained by the quickest German train, viz., the Berlin-Hamburg D-Zug, which runs through a distance of 286 kilometers (177½ miles) in 3½ hours, while the speed of ordinary German expresses is only 70 kilometers (43½ miles) per hour. The portions of lines chosen for these runs are nearly level and have few curves.

It is said that a new road 15 miles long is proposed in Northern Michigan to carry ore to Lake Superior from the mines, and that in this distance the total grade amounts to 800 feet. The freight will be almost entirely iron ore, and the cars carrying it will return empty to the mines. It is suggested that the cars be run in trains of 10 each, each train being supplied with an electric generator, connected with the axles. The grade is such that the loaded cars would run by their own weight, and the dynamos generate a current, which could be taken off upon a trolley wire and used to haul the empty cars back. It is thought that the difference in weight of the loaded and empty cars will give power enough to overcome all leakage, friction, etc. The engineers are figuring on using the dynamos as motors on the return trip, and thus saving expensive machinery.

It was shown by M. H. Moissan, about three years ago, that when iron was saturated at 3,000 degrees C. with carbon, and then cooled under a high pressure, a portion of the carbon separated out in the form of diamond. It occurred to M. Rossel, *Comptes Rendus*, July 13, that the conditions under which very hard steels are now made should also result in the formation of diamonds; and an examination of a large number of samples of such steel has shown that this is really the case. The diamonds are obtained by dissolving the metal in acid, and then subjecting the residue to the action of concentrated nitric acid, fused potassium chlorate, hydrofluoric and sulphuric acid successively. The crystals are very minute—the largest attaining only 0.5 millimeters in diameter, but Nature says they present all the chemical and physical properties of true diamonds.

In a paper by Mr. Price Williams, written to prove that the terminal charges admissible by the British Board of Trade railway rate schedules were inadequate, he quotes traffic statistics from the London & Northwestern Railway to show the large proportion of receipts absorbed for station or terminal charges. The

cost of running passenger trains is given as 2s. 5½d. per train-mile, of which 1½d., or 38.8 per cent., is for terminal charges. In the case of freight traffic the expenses are 4s. 11½d. per train-mile, and of this the terminal charges absorb 3s. 2d., or 63.57 per cent., while of the 1s. 1d. expenses involved for each mile run by mineral trains 4½d., or 37.13 per cent., are required for station terminals. Undoubtedly the percentages are lower in this country where the average haul for both freight and passengers is much greater, but we think it will be found upon investigation that there are large savings possible here by better and more enlightened practice in and about terminals.

In the operation of water-tube boilers a good automatic feed is a valuable aid in maintaining the proper water level. Mr. Yarrow, well-known in England for his work as a shipbuilder, and for the water-tube boiler he has invented and built for many government vessels, has in some recent boats adopted an automatic feed invented by Mr. Mariner, a manager in the Yarrow works. The system consists in feeding each boiler separately by a Worthington donkey pump, and placing the mouth of the steam pipe for supplying the donkey close to the water level of the boiler. If the water rises too high it will enter the donkey steam pipe and choke the cylinder with water. Then the donkey will almost stop. If the water level falls, then the donkey will work fast and pump the level up again. It has been found that when the water enters the steam cylinder the pump does not pound in an objectionable manner, as might perhaps be expected. The pump does not stop when the water enters the steam pipe, but runs slowly because the steam cylinder is larger than the water cylinder, the pump actually taking more water out of the boiler than it puts in. The heat in the water taken from the boiler is not lost, but is returned to it. It is said that in a recent three-hours' trial of a torpedo boat having this feed, the valves were not touched once.

The steamship *Germanic*, of the White Star Line, is to have a new set of engines built by Messrs. Harland & Wolff. The old engines were compound with two high-pressure and two low-pressure cylinders, arranged with the high-pressure cylinders on top of the low. These engines propelled the boat across the Atlantic 422 times, or a distance of over 1,000,000 miles. The progress in marine engineering during the last twenty years is well illustrated by a comparison of the old with the new engines. The old engines had two high-pressure cylinders, 48 by 60 inches, and two low-pressure cylinders 83 by 60 inches. The boiler pressure was 60 pounds, and at a speed of 50 revolutions they developed 5,700 indicated horse power. The boilers had 19,500 square feet of heating surface and 680 square feet of grate. The new engines are triple expansion, with cylinders 35½, 58½ and 96 inches in diameter and 69 inches stroke. The steam pressure has been increased to 170 pounds, and the new boilers have 18,169 square feet of heating surface and 558.6 square feet of grate. The new engines develop 6,500 horse power.

The construction of the Bergen Railway in Norway is now in full progress, and is attended with more engineering difficulties than have hitherto been met with in railway construction in that country. One of the most interesting features of the line is a tunnel 17,570 feet long. The snowfall in the country traversed by the line has been studied. It varies considerably; *Engineering* says that in some winters the depth averages three feet or four feet, while in others it is more than six feet. On the more exposed spots there is generally but little snow, while in hollows it may be 12 feet to 16 feet deep. The Voss-Tangevand section (about 46½ miles) rises from a minimum of 180 feet to a maximum height above the level of the sea of 4,330 feet. This section will entail an expenditure of about £800,000, of which £150,000 will be required for the Gravelhalsen tunnel, the construction of which has been contracted for by a firm of Norwegian engineers. The works on the west side of this tunnel were commenced last autumn, and the rock has so far principally consisted of a hard slate. Operations are now about to begin at the other end of this tunnel, the completion of which is fixed for Oct. 1, 1903. At both ends water power is available for the working of boring machines, ventilators, &c. A large portion of that section lies above the forest boundary.

In a paper read before the American Society of Mechanical Engineers by J. M. Whitman, on the effect of retarders in the fire-tubes of steam boilers, the results of experiments are given and the following conclusions derived therefrom: 1. Retarders in fire-tubes of a boiler interpose a resistance varying with the rate of combustion. 2. Retarders result in reducing the temperature of the waste gases, and in increasing the effectiveness of the heating surface of the tubes. 3. Retarders show an economic advantage when the boiler is pushed, varying in the tests from 3 to 18 per cent. 4. Retarders should not be used when boilers are run very gently, and when the stack draft is small. 5. It is probable that retarders can be used with advantage in plants using a fan or steam blast under the fire, or a strong natural or induced chimney draft, when burning either anthracite or bituminous coals. 6. Retarders may often prove to be as economical as are economizers, and will not, in general, interpose as much resistance to the draft. 7. Retarders can be used only with fire-tubular boilers. 8. The economic results obtained on the boiler tested are ideal, showing that it was clean, the coal good in quality, and the firing skillful. With retarders the tubes are more effectively cleaned than without their use. 9. The tests prove that the marine practice of using retarders is good, and that the claim, often advanced, that they show from 5 to 10 per cent. advantage, holds, whenever the boiler plant is pushed and the draft is strong.

If the building of the battleship *Oregon* had been a co-operative enterprise in which nine-tenths of the men of the Pacific coast had personally participated, the satisfaction, not to say self-satisfaction, of the population could scarcely be more ingeniously displayed. The *Oregon* has revealed to the Pacific coast that it can build ships with the best, that the Union Iron Works of San Francisco can even beat the yards of the Cramps, for the new battleship's maximum of 17.34 and average of 16.79 take what is known in the world of battle as the belt. The workmen of the yards were only a little more demonstrative than the rest of the population when they tied ropes to the carriage of Irving M. Scott, the *Oregon's* builder, decked the same with flowers, and dragged him about, hundreds strong, as in a triumphal car. Mr. Scott made a speech to the men who had done the actual work on the battleship, recalled the Eastern taunt of a few years ago that the Union Iron Works constituted only a plant on paper, and, holding up some of the flowers, announced that he would save them for a bouquet to lay on the grave of the once-scornful Cramps. It has been proved that the Pacific coast can build war-ships; magnanimity and a sense of humor will come later.—*Harper's Weekly*.

The East Coast Route between London and Scotland has put some beautiful new trains in service recently. The cars have numerous features that are American. They have corridors the length of the cars, end doors, Gould vestibules, couplers and platforms, Westinghouse brakes, and car-heating apparatus of American manufacture. The cars are each 63 feet long. The construction of such cars is not without its significance. *Engineering* says in commenting upon the new trains: "After a very long life the British railway carriage with its independent compartments begins to show signs of having passed its meridian." It is to be noted, nevertheless, that this innovation is on a long distance train, and it is probable that if it finds favor at all it will be confined to long distance travel. Mr. Worsdell, Locomotive Superintendent of the North-Eastern Railway, has designed and constructed five express engines for these East Coast trains. The cylinders are 20 inches in diameter, and have a stroke of 26 inches. There are four coupled wheels 7 feet 7½ inches in diameter, and there is a four-wheel bogie. The boiler is 4 feet 4 inches in diameter and over 11 feet in length. The firebox is 7 feet long, and the center of the boiler from the rails is over 8 feet. The boilers are constructed to carry a pressure of 200 pounds per square inch. In addition to the five engines already completed, 10 others are under construction, and a large number of tenders are being fitted up with the water scoop. It is evident, therefore, that the East Coast Route is ready to compete for the traffic to Scotland,

either by excellence of accommodation or by a good showing in another "race to the north."

In the evening of August 8, a peculiar accident happened at the Brooklyn Navy Yard. The caisson or gate of dry dock No. 2 gave way and as the dock was empty at the time the inrush of water tore a number of vessels from their moorings. A pile driver, a lumber lighter and the torpedo boat *Eriessan* were carried into the dock and the latter's bow was badly damaged. The steam launch of Commodore Sicard was wrecked and sunk inside of the dock. The war vessels *Atlanta*, *Katalin*, *Terror* and *Puritan* were carried into the channel and toward the dock by the current, but were caught and towed back to their moorings before any damage was done them. The dock and the gate were both damaged and the total bill for repairs is variously estimated to be from \$100,000 to \$250,000. The gate is of steel and was ballasted with rock which had nearly all been removed preparatory to putting a ballast of concrete, and to its lightened condition is attributed the accident.

An interesting method of testing lubricants when a regular oil tester is not at hand, but where electrical apparatus is available, was recently described by Mr. P. MacGahan, in the *Electrical World*. It consists of employing a shaft driven by a small shunt wound electric motor and fitting it with two bronze or babbitt metal boxes, so arranged that a known weight can be applied to them and the lubricant properly introduced. The speed of the motor can be regulated within one per cent. by means of a water barrel in the armature circuit and rheostat in the field circuit. The power supplied to the motor is observed by means of a watt-meter. The watts required when there is no pressure on the bearing is deducted from the readings obtained when the pressure is put on. From the watts used the speed of the rubbing surfaces and the pressure, the co-efficient of friction can be accurately determined. The equation

$$F = \frac{W \times 44.2}{S}$$

gives the friction in pounds, W being the watts consumed, S the speed of the rubbing surfaces in feet per minute, 44.2 the foot-pounds per watt expended, and F the friction in pounds; whence we obtain

$$K = \frac{F}{P} = \frac{W \times 44.2}{PS}$$

where K is the co-efficient and P the total pressure on the bearing.

In an article in the *Iron Age*, Mr. P. Kreuzpointner made the following comparison between test pieces of various lengths and areas. A few results of tests given below will illustrate better than any words the remarkable difference between the extremes of modern test section, where the 8-inch section comes nearest the natural conditions of the full-sized plate or structural member, while the 1-inch or groove section is further from it, hence giving fictitious values. While a test section where elongation is measured in 10 or 12 inches would still be nearer to the ideal, the difference between these and an 8-inch length is so small that it can be omitted in practice, saving thereby a good deal of metal and cost of preparation:

ELONGATION WITH GEOMETRICALLY DISSIMILAR TEST PIECES.

PER CENT.

2½ by ¼ inches.	1½ by ¼ inches.	¾ by ¼ inches.	In inches.
67	61	55	1
50	43	40	2
36	31	30	4
30	26	26	6
27	24	23	8

TENSILE STRENGTH.

Test Section, 1½ inches by ¼ inch.

Length of section in inches.....	1	2	4	6	8
Pounds per square inch.....	72,000	65,100	62,700	60,300	59,000

In the last report of the Australian Railway Commissioners par-

ticulars were given of a new locomotive, which had been designed under their directions especially to meet the requirements of the New South Wales lines. It is aptly named the "Australian Consolidation" engine and considerable interest has been attracted by the appearance of the first of the engines in steam. The trial runs, it is understood, were most satisfactory, indicating that the new locomotive fully meets all that was desired when it was designed. The New South Wales *Railway Budget* says that the engines, five in number, have recently arrived and have been put together at Eveleigh. They are big engines, necessarily so, to perform the work set them, and have been built by Messrs. Beyer, Peacock & Company, Limited, detail drawings, specifications, etc., having been prepared by the Chief Mechanical Engineer in Australia. The engines are designed in accordance with the English practice permitting of plate frames, copper fireboxes and brass tubes being used. The journals and crank pins are encased in dust proof shields, a very desirable protection in dry climates, such as are met with on many of the New South Wales main lines. These engines have outside cylinders 21 inches diameter by 26-inch stroke, with eight coupled wheels, and a two-wheeled radial truck; the Westinghouse automatic brake is applied to all the coupled wheels. The valve motion is of the Allan straight-link type, with balanced slide valves, and trick ports. The boiler and fire box are constructed on the Belpaire principle, working at a steam pressure of 160 pounds per square inch, and containing a total heating surface of 2,211 square feet, with a grate area of 29.75 square feet. The tenders are of the double bogie type, capable of carrying 3,650 gallons of water and six tons of coal, and are equipped with the Westinghouse automatic brake.

	Ft.	In.
Diameter of coupled wheels.....	4	3
Coupled wheel-base.....	15	0
Total wheel base of engine.....	23	2
Total wheel-base of tender.....	16	0
Total wheel-base of engine and tender.....	51	10½
Total length over buffers.....	60	3¾
Centers of cylinders transversely.....	7	11
Width over cylinders outside.....	9	2¾
Height of center of boiler above rails.....	7	8

The haulage power (exclusive of engine and tender) that it was estimated the engine could manage on a 2½ per cent. grade was 350 tons, at a speed of 10 miles per hour, and it is said that on the trial runs this has been satisfactorily covered.

The Prussian State railways are experimenting with a new composition of oils and fats for lubricating car axles. The following test was made with the new lubricant on Corridor Car No. 562, running between Berlin and Frankfurt-on-Main: The new lubricant was applied in all the eight axle boxes. The method of application was to impregnate 16 cushions, made of a cheap shoddy material, with the new lubricant, and placing these, the one under and the other over the axles in each box. The remaining space was filled up with the composition. The total weight of lubricant thus applied was 16 kilogrammes. The car was run in the regular passenger train service, and after running 5,000 kilometers a slight addition of the lubricant was made in each axle box. At the end of a run of 30,000 kilometers the car was held over at the Berlin station and a careful inspection made. The cushions were removed and weighed, and likewise the composition in the axle boxes carefully taken out and weighed. The cushions and grease were replaced in the boxes with some addition of fresh material, an exact record of weight being kept. This was repeated as each 30,000 kilometers of train services were run by the car. The saving, according to the official figures, comes out at 15.84 marks per 30,000 kilometers of train service, or about one-half of present cost per car. The severest cold weather of Northern Europe does not have any effect on the composition, as its freezing point is 28 degrees Centigrade. On the other hand, the warmest weather does not cause the composition to run. The results of the tests may be summed up approximately as follows: One application of lubricant suffices for 3,100 miles of train service, and in running 55,800 miles the consumption is about 69 pounds, which is about 1½ grains per 100 miles run for each axle box. The Prussian Government pays about 15c. per pound for the composition.

Personals.

Mr. William W. Borst has been appointed Receiver of the Denver, Lakewood & Golden Railroad.

Mr. E. P. Ripley has been elected President of the Sonora Railway and New Mexico & Arizona Railroad.

Mr. H. Fegraus, of Duluth, Minn., has been appointed Chief Engineer of the Duluth & North Dakota.

Mr. J. P. Lyman, General Manager, has also been elected President of the Chicago, Hammond & Western.

Mr. N. Monsarrat has been elected Vice-President of the Columbus, Hocking Valley & Toledo Railway.

C. Millard has been appointed Chief Engineer of the St. Louis, Chicago & St. Paul, with office at Springfield, Ill.

Mr. J. T. Walch has been appointed Master Mechanic and Master Car Builder of the Oregon Central & Eastern.

Mr. Joseph McWilliams is now General Manager of the Marietta & North Georgia, with headquarters at Marietta, Ga.

Mr. Edward Woodbury, of Kalamazoo, has been elected President of the Chicago, Kalamazoo & Saginaw Railway.

Mr. Wm. Rutherford, Superintendent of Motive Power and Equipment of the Plant System of Railways, has resigned.

Mr. John Oliver, formerly for 15 years Purchasing Agent of the Baltimore & Ohio, died at Baltimore, Md., July 15, after a long illness.

Mr. R. B. Levy, Sr., has been appointed Receiver of the Texas, Sabine Valley & Northwestern, to succeed Mr. Leon H. Hart, resigned.

Mr. J. L. Polk has been appointed Acting General Manager of the Gulf, Colorado & Santa Fe, to succeed Mr. B. F. Yoakum, resigned.

Mr. Jonathan Evans has been appointed Master Mechanic of the Washington & Columbia River Railway, vice William Saxton, resigned.

Mr. D. W. McLean, Master Car Builder of the Kansas City Fort Scott & Memphis at Fort Scott, Kan., died at Grand Rapids, Mich., July 27.

Mr. Thomas Inglis, Master Mechanic of the St. Louis Southwestern, at Tyler, Tex., died recently. He is succeeded by Mr. J. M. Scrogin.

Mr. William S. McGowan, Jr., has been elected Treasurer of the Hancock Inspirator Company, of Boston, vice Mr. Edward P. Noyes, resigned.

Mr. William Whyte, Superintendent of the Texas Trunk, has been appointed Receiver of that road to succeed Mr. George T. Atkins. His office is at Dallas, Tex.

Mr. Edwin McNeil, Receiver and General Manager of the Oregon Railway & Navigation Company, has been chosen President of the reorganized company.

Mr. J. M. Schoonmaker has been elected President of the Pittsburgh, Chartiers & Youghiogheny Railway to fill the unexpired term of J. H. Reed, resigned.

Mr. D. C. Courtney has been appointed Division Master Mechanic of the Baltimore & Ohio Railroad, at Grafton, W. Va., in place of Mr. S. A. Souther, resigned.

Mr. S. B. Wight, Secretary to President Ledyard, of the Michigan Central, has been appointed Assistant Purchasing Agent of that road, with office at Detroit, Mich.

Mr. W. A. Walden, of Charlotte, N. C., has been appointed Master Mechanic of the Southern Railway at Burlington, N. C., to succeed Mr. T. S. Inge, transferred to Columbia, S. C.

Mr. E. T. Smith has resigned as Purchasing Agent of the St. Louis & San Francisco, and the office is abolished. General Manager Yoakum will hereafter look after the purchase of supplies.

Mr. S. R. Tuggle, Superintendent of Motive Power and Machinery of the Houston & Texas Central, has also been made Superintendent of Motive Power and Machinery of the Galveston, La Porte & Houston.

Mr. Charles Warren, General Manager of the Great Northern, has retired. Mr. James M. Barr, General Superintendent, has been assigned certain duties heretofore performed by the General Manager, and the latter office will be abolished.

Mr. W. E. Guerin has been elected President of the Columbus, Sandusky & Hocking Railroad, to fill the vacancy caused by the resignation of N. Monsarrat. Mr. Charles Parrott has been elected Vice-President, to fill the vacancy caused by the election of Mr. Guerin.

Mr. Edward S. Washburn, Vice-President of the Kansas City, Fort Scott & Memphis, has been chosen President of that road and the Kansas City, Memphis & Birmingham. It is announced that he will also assume the duties of General Manager of the roads named and associated lines.

Mr. Joseph A. Jordan, General Manager of the St. Louis & Hannibal, has been elected Vice-President of the Green Bay & Western, which has but recently been reorganized, to succeed the Green Bay, Winona & St. Paul. Mr. Jordan will continue as General Manager of the St. Louis & Hannibal.

Mr. F. P. Olcott has been elected President and Mr. J. H. Hill General Manager of the Galveston, Houston & Henderson road in Texas. Mr. Hill was appointed to this office some months ago, but has not yet been placed in active charge of the operation of the line, which still continues under the direction of the Operating Department of the International & Great Northern.

Mr. A. L. Studer, Master Mechanic of the West Iowa Division of the Chicago, Rock Island & Pacific, at Stuart, Iowa, has been appointed Master Mechanic of the Southwestern Division, in charge of the Locomotive and Car Department, with headquarters at Trenton, Mo., to succeed Mr. William Gessler, resigned. Mr. J. B. Kilpatrick is given jurisdiction over the West Iowa Division in addition to his other duties.

Mr. Frederick Harrison, General Manager, and Mr. Robert Turnbull, General Superintendent, of the London & North Western Railway, of England, arrived in New York by the Cunard line steamer *Lucania* on Saturday, Aug. 22. These gentlemen are coming over on a tour of recreation and observation, and after two days' stay in New York, will proceed to the Pacific Coast, visiting all places of interest en route in the States and Canada, returning to New York in October. They will be entertained by a large number of American railroad officials, and every facilitation will be afforded them to inquire into the American system of railroads, etc.

Mr. Robert Garrett, formerly President of the Baltimore & Ohio road, and the son of Mr. John W. Garrett, who did so much in the building up of the road, died on July 29. Mr. Garrett was born at Baltimore in 1847, and was graduated from Princeton University in 1867. After a short training in the banking house of his father he entered the railroad field, being made President of the Valley road of Virginia in 1871, Third Vice-President of the Baltimore & Ohio in 1879, First Vice-President in 1881, and President in 1884 on the death of his father. In October, 1887, he resigned the Presidency, and Mr. Samuel Spencer became President. During Mr. Garrett's administration the Philadelphia division of the road was built, and the B. & O. express and telegraph lines were built up only to be sold out at a great loss.

Equipment Notes.

Five locomotives are under construction at the Brooks Works for the Chicago, Rock Island & Pacific Railway.

The Michigan Central is building three new locomotives, two switch and one passenger, at its St. Thomas shops.

It is stated that the Lake Shore & Michigan Southern will order soon 12 or more locomotives and about 900 freight cars.

The Chicago, Rock Island & Pacific Railway has ordered 100 coal cars to be built by the Michigan Peninsular Car Company.

A contract for building ten Page dump cars has been let to the United States Car Company, and will be built at Hegewich.

The Great Northern has placed an order with the Brooks Locomotive Works for 12 mogul engines with 19 by 26-inch cylinders.

It is reported that the Chicago & Northwestern contemplates adding about 5,000 new freight cars to its equipment during the year.

The Indiana Pipe Line and Refining Company has placed an order of fifty 8,000 gallon tank petroleum cars with the Terre Haute Car Works.

The Illinois Central has contracted for the construction of six ten-wheeled and eight eight-wheeled passenger locomotives, five moguls and four six-wheeled switchers. This order is divided between the Brooks and Rogers Locomotive Works.

The Pittsburgh Locomotive Works recently delivered to the Seaboard Air Line twelve ten-wheel engines with cylinders 19 by 24 inches. They have also shipped lately two six-wheel connected side tank engines with cylinders 13 by 20 inches for the Ota Railway of Japan.

The records of the Georgia courts show that the cars recently ordered by the Georgia Railroad from the Ohio Falls Car Manufacturing Company are to cost as follows: Two hundred ventilated box cars, \$434 a car; 65 drop-bottom gondolas, \$340 a car; 50 platform cars, \$286 each, and 10 stock cars, \$414 each.

Instating in our July issue that the Richmond Locomotive Works had not received an unqualified order for altering over 60 Big Four engines to the compound system, we were in error. The order has been given for the entire 60 engines, but, of course, the work of alteration will be carried out only as the engines come in the shop for general repairs.

H. K. Porter & Company, of Pittsburgh, some time ago secured a contract for equipping the Eckington and Soldiers' Home Street Railway of Washington with traction cars and compressed air motors. The new cars will resemble ordinary cable cars and will be about 20 feet long. The power will be placed beneath the seats and the floor of the car. The air will be stored in eight iron retorts nine inches in diameter and as long as the car. The air will be stored at a pressure of 2,000 pounds to the cubic inch. The air pressure in the storage tanks is reduced before used in the motor and is to be heated by passing it through hot water. The power is regulated by ordinary levers, and the system is almost identical with a steam or compressed air locomotive.

Report of the Committee on Fire-Proofing Tests.

The following report, addressed to the Tariff Association of New York, the Architectural League of New York and the American Society of Mechanical Engineers is of unusual interest. The joint committee appointed to investigate and test fire proofing for structural metal in buildings and to obtain data for standard specifications, is as follows: S. Albert Reed for the Tariff Association, Geo. L. Heins for the Architectural League and H. de B. Parsons and Thomas F. Rowland, Jr., for the American Society of Mechanical Engineers. The committee, after having effected its own organization, determined to add to its numbers by the creation of an Advisory Board. This step was taken for the purpose of more widely increasing the interest taken in the experiments, and also to prevent, as far as possible, the impression that the work was of a sectional or local character. The names of the gentlemen who accepted invitations to serve on this Advisory Board are as follows:

Edward Atkinson, President Boston Manufacturers' Mutual Fire Insurance Company.

Osborne Howes, Secretary Boston Board of Fire Underwriters, Charles A. Hexamer, Secretary Philadelphia Fire Underwriters' Association.

W. Martin Aiken, Supervising Architect, United States Treasury Department, representative Illinois Chapter, American Institute of Architects.

George B. Post, New York Chapter, American Institute of Architects.

Stevenson Constable, Superintendent of Buildings, New York. F. H. Kindt, Structural Engineer, Carnegie Steel Company. John R. Freeman, Chief Instruction Department, F. M. I. Companies.

Henry Morton, President Stevens Institute of Technology. C. H. J. Woodbury, member American Society of Civil Engineers. H. B. Dwight, Dwight Survey and Protection Bureau, New York.

F. C. Moore, delegate New York Board of Underwriters to Board of Examination of Department of Buildings.

Wm. A. Wahl, Secretary Franklin Institute, Philadelphia. John T. Williams.

The committee publicly thanks the parties mentioned below for their offers of assistance, namely: The Continental Iron Works, for permission to use part of their yard and for numerous courtesies which have been extended to the committee from time to time; the Carnegie Steel Company, Limited, for their offer to furnish all the structural steel that the committee may need; J. B. & J. M. Cornell, for their offer to furnish the cast iron columns for which the committee may ask; Sinclair & Babson, for their donation of 75 barrels of Alsen cement; the Lorillard Brick Works Company, through Henry M. Keasbey, for 54,000 common bricks; Henry A. Maurer, for his donation of 14,000 fire bricks and 14 barrels of fire clay.

The report says:

During the winter just past your committee erected a testing plant, as shown in the accompanying photograph, Fig. 1. The gas producer in the background is 9 feet in diameter by 12 feet in



Fig. 1.—View of Testing Plant.

height, and is equipped with a hopper valve on top. Gas is generated by means of steam from the boiler, as shown, and carried into the furnaces through pipes, as clearly indicated in the photograph. The foundation shown on the left is ready for the erection upon it of a furnace for testing beams and floors. Its dimensions are: length, 27 feet; width, 12 feet; but it can be arranged to take larger beams if so desired. The furnace shown on the right is for testing columns, and is 14 feet square, outside measurement.

The arched roof is made of fire brick and is independent of the side walls, being supported by outside corner posts. The walls are of common brick, but can easily be changed so that experiments can be made on other materials. One side wall and the end wall with the door are 12½ inches in thickness; the rear wall is 8½ inches, and the fourth wall is 4 inches inside, 2 inches air space and 8½ inches outside, making a total thickness of 14½ inches.

The floor is covered with fire brick, with openings left for the branch gas pipes and air spaces to support the combustion. These branch gas pipes are 4 inches in diameter, capped with tuyeres reduced to 2 inches. In order to increase the temperature when desired, a barrel of naphtha is connected by means of a small pipe and blown into the gas pipe at the Y-branch by means of a steam jet.

The column is placed in compression by means of a hydraulic ram underneath, resting on three 24-inch I-beams the same as those across the top of the furnace shown in photograph. In order to keep the entire length of the column within the furnace filler blocks of cast-iron are placed between the ends of the column and these I-beams. The hydraulic ram is 12 inches in diameter and the water

LOG OF TRIAL.

Time.	Pyrometer.	Hyd. pressure.		
H. M.	Deg. Fahr.	Total load,	tons.	Remarks.
2.23	80	....	81.8	Pyrometer point 3 feet from column.
2.21	200	81.8	81.8	Wood fire lit.
2.30	630	81.8	81.8	Gas turned on.
2.35	1,400	81.8	81.8	One-quarter cock of naphtha.
2.38	1,375	81.8	81.8	Naphtha closed.
2.40	1,125	81.8	81.8	One eighth cock of naphtha.
2.41	1,175	81.8	81.8	Naphtha cock closed to "dropping."
2.45	....	81.8	81.8	Pyrometer moved to 2 feet from column as flame touched point.
2.46	1,125	81.8	81.8	Column began to yield.
2.47	1,121	81.8	81.8	Column yielding fast.
2.49	1,110	81.8	81.8	Impossible to maintain hydraulic pressure.
2.51	1,400	81.8	81.8	Pump and gas stopped.
2.52	900	81.8	81.8	Pyrometer closed.

STRENGTH OF GORDON'S FORMULA.

Breaking strength per square inch, 12,820 pounds.

Area of cross-section, 11.15 square inches.

Breaking load, 14.15 by 12,820, 65,900 pounds, 303 tons.

Column Test No. 3, June 30, 1896.—Fire test without water; cast-iron column furnace same as Tests 1 and 2.—The column was a cast-iron, hollow, round column, with flanges faced on both ends, as shown in Fig. 3, and was uncovered. It was cast horizontally, with a dry sand core, by the Cornell Iron Works, New York. The weather was clear and warm, with a slight breeze from the southwest. Temperature of air, 75 degrees Fahr.

LOG OF TRIAL.

Time.	Pyrometer.	Hyd. pressure.		
H. M.	Deg. Fahr.	Total load,	tons.	Remarks.
2.32	....	14.1	81.8	Wood fire lit.
2.45	....	81.8	81.8	Gas lit, door being closed.
2.50	....	81.8	81.8	Pyrometer in place, 18 inches from column.
2.51	375	81.8	81.8	Gas shut off to poke producer.
2.57	925	81.8	81.8	Removed some loose bricks that interfered with tuyeres.
3.00	475	56.5	81.8	Gas turned on, door closed.
3.05	450	28.2	81.8	Air openings closed.
3.06	650	15.5	81.8	Door down to arrange bricks.
3.08	967	....	81.8	Door closed.
3.12	690	11.3	81.8	Naphtha valve opened one-half.
3.13	650	....	81.8	Slight redness reported by some.
3.13½	750	....	81.8	Column bent slightly.
3.37	1,125	81.8	81.8	Gas shut off, door down, column decidedly red and bent.
3.40	1,137	81.8	81.8	Gas on and door closed.
3.55	1,200	81.8	81.8	No naphtha.
4.01	387	81.8	81.8	Naphtha turned on one-half cock.
4.08	925	81.8	81.8	Gas shut off, stopped pumping.
4.09	925	81.8	81.8	
4.32	1,125	81.8	81.8	

Strength by Gordon's formula was as follows:

Breaking strength, 992,000 pounds.

Safe load $\frac{1}{2}$ by 992,000, 180,400 pounds, 90.2 tons.

The result of test No. 3, is shown in Fig. 5.

Column Test No. 4, July 6, 1896.—Fire test without water; cast-iron column furnace same as Tests 1, 2 and 3.—The column was a cast-iron, hollow, round column, with flanges faced on both ends, and was uncovered. It was cast horizontally with a dry sand core by the Cornell Iron Works, New York. The column was the same as illustrated in the cut (Fig. 3), with the following exceptions: Length over all, 13 feet $\frac{1}{2}$ inch thickness of flanges, 1½ inches flanges re-enforced by four ribs each seven-eighths inch thick, reaching from outer end of flange to cylinder at an angle of about 45 degrees.

LOG OF TRIAL.

Time.	Pyrometer.	Hyd. pressure.		
H. M.	Deg. Fahr.	Total load,	tons.	Remarks.
2.22	....	....	81.8	Wood fire fire lighted.
2.25	....	81.8	81.8	Gas lighted.
2.28	....	81.8	81.8	Pyrometer placed 18 inches from column.
2.29	....	81.8	81.8	Door closed.
2.30	675	81.8	81.8	Naphtha used, one-quarter cock.
2.49	1,100	81.8	81.8	More naphtha, three-eighths cock.
2.51	1,125	81.8	81.8	More gas.
2.53	1,200	81.8	81.8	Column bending.
2.54	1,300	81.8	81.8	More naphtha, half cock.
2.57	1,350	81.8	81.8	Color reported.
2.59	1,350	81.8	81.8	Column yielding fast.
3.01	1,375	81.8	81.8	Column breaking suddenly.
3.03½	1,525	81.8	81.8	
3.05	1,550	81.8	81.8	

The fracture occurred at the center of the column, Fig. 6, where the deflection was the greatest. There was a crack about 5 inches long about 7 inches above the fracture on the convex side of the column, showing that the column first pulled apart on the outside of the bend. No water was thrown on this column during the test.

Column Test No. 5, July 10, 1896.—Fire test with water. Cast-iron column. Furnace same as Tests Nos. 1, 2, 3 and 4.—The column was a cast-iron, hollow, round column, with flanges faced on both ends, and was uncovered. It was cast horizontally with a dry sand core, by the Cornell Iron Works, New York. The column

was the same as illustrated in Figure 7, with the following exceptions: Flanges were 1½ inches thick, and were re-enforced with four ribs, as in test No. 4. There was a slight defect in this casting, there being a porous portion a few inches long on one side about 3 feet 6 inches from the lower end.

Water was thrown upon the column through about 50 feet of



Fig. 5.

Fig. 6.

Fig. 7.

Fig. 4.

2½-inch rubber hose and a three-quarter-inch nozzle. The pressure at the hydrant was 50 pounds.

LOG OF TRIAL.

Time.	Pyrometer.	Hyd. pressure.		
H. M.	Deg. Fahr.	Total load,	tons.	Remarks.
2.16	....	81.8	81.8	Wood fire lighted.
2.28	....	81.8	81.8	Gas lighted.
2.29	690	81.8	81.8	Door closed. Pyrometer in place 18 inches from column.
2.36	675	81.8	81.8	Pyrometer moved back 5 feet from column.
2.42	525	81.8	81.8	Water thrown on column one minute.
2.43	450	81.8	81.8	Door open. Fire out.
2.44	400	81.8	81.8	Door open. Fire relighted.
2.46	125	81.8	81.8	Door closed.
2.58	750	81.8	81.8	Pyrometer 3 feet from column.
3.02	750	81.8	81.8	Pyrometer 18 inches from column.
3.05	785	81.8	81.8	Pyrometer 5 feet from column.
3.09	400	81.8	81.8	Water on column half minute. Fire out. Door down.
3.16	....	81.8	81.8	Gas relighted. Door closed.
3.19	685	81.8	81.8	Pyrometer 18 inches from column.
3.22	700	81.8	81.8	More air admitted.
3.35	1,025	81.8	81.8	Column red.
3.50	1,150	81.8	81.8	Water on column half minute. Fire out. Door down. More water on column as it was still red.
3.55	1,075	81.8	81.8	Gas relighted.
4.13	....	81.8	81.8	Pyrometer 18 inches from column.
4.17	750	81.8	81.8	Naphtha, half cock.
4.21	787	81.8	81.8	Column getting red.
4.30	1,250	81.8	81.8	Column bending.
4.31	1,275	81.8	81.8	Pyrometer moved back. Water on column one minute.
4.34	1,300	81.8	81.8	Door down and water on column again two minutes.
4.35	....	81.8	81.8	

The result of the test is shown in Fig. 7.

The column was very red when the water was thrown on it the last time. The brick walls and arch roof cracked when water fell on them. The column was badly bent, but otherwise appeared uninjured.

THE MOST ADVANTAGEOUS DIMENSIONS FOR LOCOMOTIVE EXHAUST PIPES AND SMOKESTACKS.*

BY INSPECTOR TROSKE.

(Continued from Page 192.)

VI.—INFLUENCE OF THE INCLINATION OF THE STACK UPON THE VACUUM.

a. With the Same Bottom Diameter.

It has already been seen and discussed with reference to Plate II., in which the waist-shaped stacks are represented, that, within certain limits, the lowest vacuum is obtained with that stack which, having the same bottom opening, flares out to the largest diameter at the top. Plate VI. under C illustrates the same fact, and it is shown in a still more convincing way relatively to the funnel-shaped stacks under B in Plate V. In the latter plate the lines of the diagram placed together for two stacks having a diameter of 13.78 inches at their smallest section and with inclinations of one-twelfth and one-sixth respectively.

We see from these diagrams that the full length stack with the straightest sides produces 60 percent greater vacuum than the stack having the same bottom diameter but a greater flare.

Zeuner reached the opposite opinion in his theory of conical stacks as stated in Section I.

Fig. 56 shows, on a larger scale, the relationship of the two conical stacks to each other when the nozzle diameter is 4.74 inches. The nozzle distances (abscissas) are here shown in a scale of $\frac{1}{2}$ their full size, while the corresponding vacuum (the ordinates) is shown on a scale of half size. But it is possible, as we have al-

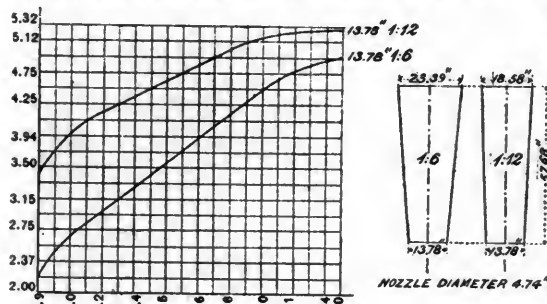


Fig. 55.

ready demonstrated, to obtain the same action with both stacks by using a greater nozzle distance with that stack which has the greater flare. According to Plate V. this must average about 12.60 inches greater in the stack with $\frac{1}{6}$ inclination than in the one having $\frac{1}{12}$.

The lines of the diagrams under A in Plate VI. show the same thing for stacks that have been shortened 19.68 inches at the top.

b. With the Same Top Diameter.

In Plate V., under C, two groups of stacks of three each are shown; they have the same top diameter but different flares or inclinations. In one group the corresponding diameters are about 2 inches larger than in the other. Both groups exhibit the same contour of lines, which shows that:

With the same top diameter, that stack creates the greatest draft which has the smallest bottom diameter and which is contracted the most toward the bottom.

The lines of the diagram under B in Plate VI. show the same thing. Here two stacks are compared that have been shortened 19.68 inches at the top and which have flares of $\frac{1}{6}$ and $\frac{1}{12}$ respectively as before. In consequence of the large amount that has been cut off from the top and the slight differences in the diameters resulting therefrom, the vacuums belonging to the two stacks do not differ so much from each other as they do in the case of the longer stacks represented in Plate V.; but the more sharply contracted stack always produces a draft about 19 per cent. greater.

In Fig. 56 we have given, on a larger scale the diagrammatic lines of two full-length stacks of the same top section, but with waists of different diameters, the nozzle diameter for both being 4.74 inches. The vacuums are represented by the ordinates and the

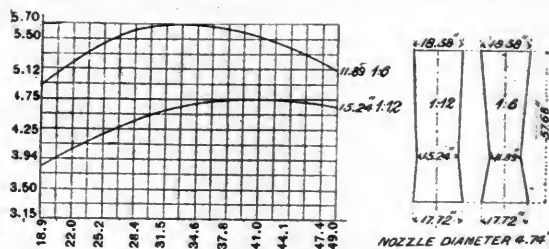


Fig. 56.

corresponding nozzle distances by abscissas. We see from the diagram, that the vacuum here increases about 1.18 inches, or 28 per cent., if the stack having a waist diameter of 15.24 inches is changed for one having a diameter of 11.89 inches, the diameter at the top remaining unchanged. These facts, taken in connection with that graphically shown in Fig. 55 for stacks having the same bottom diameter, form the basis for the statement made in section X., that in the theories of locomotive exhaust nozzles and stacks the equalization for the coörcity of the stacks must be made in another way, as is done.

The curves under C of Plate V. are not instructive when read in any other way. At the right the waist shaped stack have the sides shown prolonged in the dotted lines to the bottom, and the smallest diameter, which would then be formed, marked.

By making a comparison of the curves we can readily determine the influence of the foot of the stack, as discussed in the preceding section. For short nozzle distances, in which the current of steam does not present a sufficiently large surface for drawing in the air, the funnel-shaped stack with a flare of $\frac{1}{6}$ (especially where the diameter is small) has a weaker effect than the waist-shaped stack with the same flare; but when the nozzle distance drops to about 0.4 of the total height of the stack, the two are about equal in effectiveness, while for greater distances the funnel-shaped stack no longer appears to be superior to the waist-shaped. For all the abscissas of Plate V. both stacks have the same total heights, and agree perfectly in having their upper sections 40.02 inches long, but the difference lies in the fact that, with the funnel-shaped stacks the nozzle is always about 17.52 inches nearer the smallest section, which has a diameter of 15.75 inches than is the case of the waist-shaped stacks, with a waist 17.2 inches in diameter. Now, according to Section VIII. we find that a confined jet of steam in the experimental apparatus had a flare of about 1 in 2.4; so that at a distance of 29.92 inches (760 millimeters) from the nozzle it would have an approximate diameter of $\frac{29.92}{2.4} +$ the diameter of the nozzle, that is

with a nozzle 4.74 inches in diameter it would be $12.46 + 4.74 = 17.2$ inches.

Thus at about 29.92 inches from the nozzle opening the current of steam begins to fill the section having a diameter of 17.2 inches, so that there is no free outlet for the mantle of air that is drawn in with and surrounds the inclosed portion of the steam jet. With the nozzle opening located at a still greater distance, the passage of the steam and air will be checked still more, the consequence of which will be that there will be a still greater loss of vacuum by impingement against the side of the funnel-shaped foot and the contraction to which the current will be subjected.

The case of the funnel-shaped stack is somewhat different. Here instead of a nozzle distance of 29.92 inches from the waist in the preceding stack we have a nozzle distance of only $29.92 - 17.52 = 12.4$ inches from the smallest cross-section, so that the steam jet has a free entrance into the barrel of the stack, and the entrained air is carried through it unchecked by friction against the sides. It will be at a distance of about $x = (15.75 - 4.74) \times 2.4 = 26.42$ inches that the current of steam would begin to fill the smallest section, as shown in Fig. 57, which corresponds in Plate V. to the abscissa of $26.42 + 17.52 = 43.94$ inches. We see, as a matter of fact, that at about 3 feet $7\frac{3}{4}$ inches measured on the line of the abscissas the line in the diagram curves sharply down

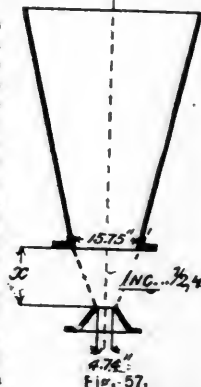


Fig. 57.

*Paper read before the German Society of Mechanical Engineers, and published in *Glasers Annalen für Geologie und Bauwesen*.

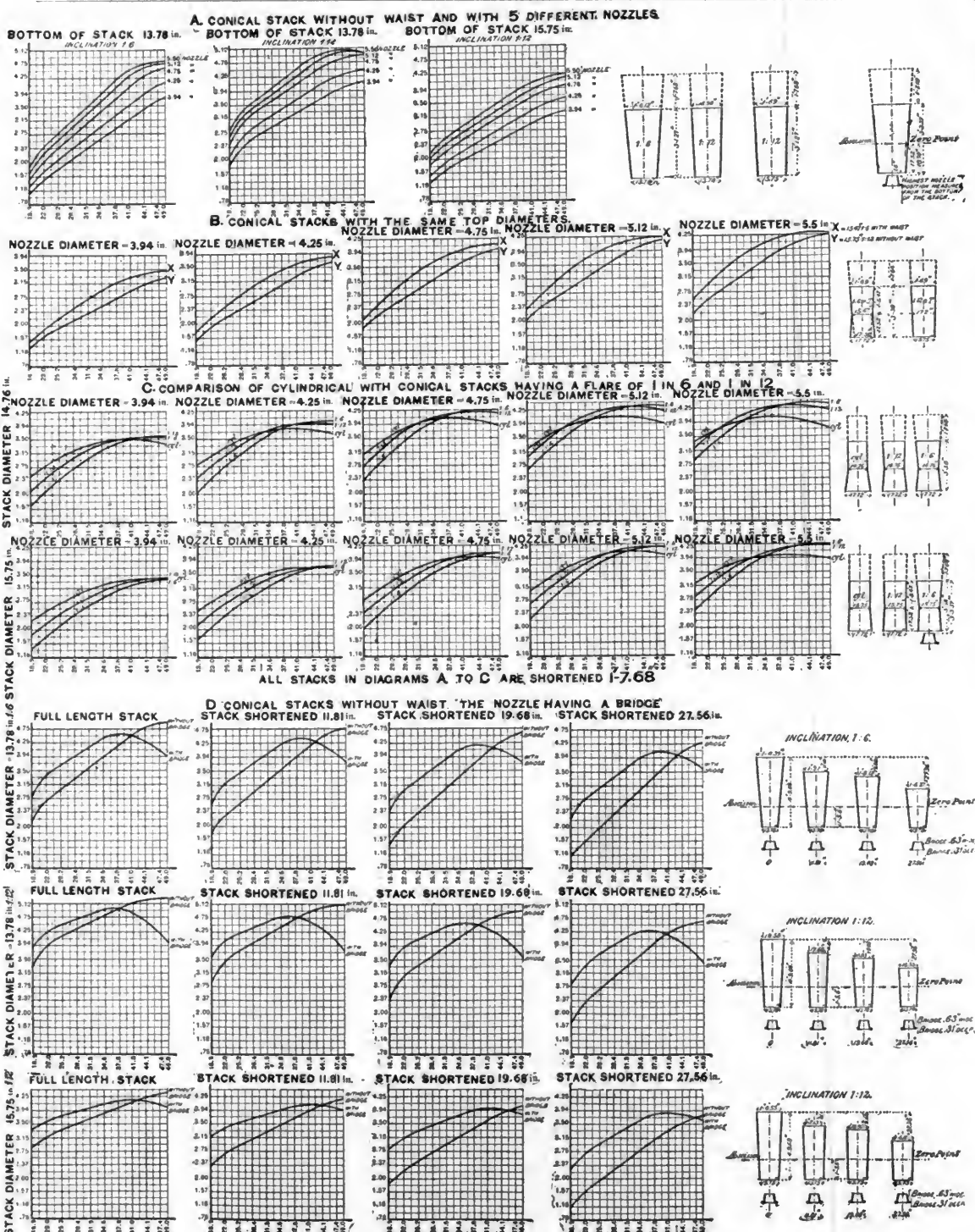


PLATE VI.—DETAIL DIAGRAM OF THE HANOVER SMOKE-STACK AND EXHAUST NOZZLE EXPERIMENTS.

REMARKS.—1. All observations with the water column were made with a constant steam pressure of 3.91 in. of mercury and with the same openings for the admission of air.

2. The abscissas, indicating the nozzle position, are all measured, on stacks without a waist from a point 17.52 in. above the smallest cross-section, and 18.9 in. above the highest position of the nozzle.

3. In the stacks represented under D, the nozzle without a bridge had an opening 4.74 in. in diameter, while the one with a bridge had an opening 5.12 in. in diameter; the breadth of the bridge being .63 in. Both nozzles thus had the same free opening.

TABLE XXII.

Comparison of the nozzle positions necessary to produce the same nozzle action (3.94 inches of water), the nozzle distance being measured from the smallest section of the stack, and the nozzle used being with and without a bridge.

Stack.		Nozzle without bridge.	Nozzle with bridge.	Shortening of the nozzle distance due to the use of the bridge.
Diameter and flare.	Length.	Inches.	Inches.	Inches.
14.76 inches ($\frac{1}{2}$) (With waist) 13.75 inches ($\frac{1}{2}$) (With waist)	Full length	6.73	.....	6.73
	Shortened 27.56 inches	25.32	11.14	14.17
	Full length	15.00	3.74	9.25
	Shortened 19.68 inches	23.43	10.83	12.60
13.78 inches ($\frac{1}{2}$) (Without waist)	Full length	17.44	10.83	6.61
	Shortened 11.81 inches	20.38	12.72	7.56
	" 19.68 "	22.32	14.32	7.40
	" 27.56 "	25.00	17.13	7.87
13.78 inches ($\frac{1}{2}$) (Without waist)	Full length	4.21	1.57	2.64
	Shortened 11.81 inches	9.84	3.15	6.69
	" 19.68 "	14.37	5.12	9.25
	" 27.56 "	19.29	10.43	8.86
15.75 inches ($\frac{1}{2}$) (Without waist)	Full length	19.02	12.01	7.01
	Shortened 11.81 inches	23.90	17.13	6.77
	" 19.68 "	28.74	20.87	7.87
	" 27.56 "	(43.90)	(32.87)	(11.02)

REMARKS.—When the stack 15.75 inches in diameter had been shortened 27.56 inches, it became impossible to maintain a vacuum of 3.94 inches any longer. The bracketed figures correspond to a vacuum of 3.51 inches.

in consequence of the reason given, and also of the loss previously shown in Fig. 44. With a stack 13.78 inches in diameter the same thing naturally occurs with a shorter nozzle distance, as shown under C in Plate V. The lines also assume the downward curvature earlier and more sharply than with the larger stack.

From these observations and from the conclusion reached above it follows:

That the efficient stack is long and that the nozzle distance should not be too great, say about .3 to .4 of the total height.

Too great a nozzle distance is to be especially avoided, especially on those locomotives hauling heavy trains, which at times work



Fig. 58.



Fig. 59.

slowly and with a late cut-off. In this case the rush of steam receives a decided check, as each exhaust spreads out, after leaving the nozzle, somewhat more sharply than is the case with an uninterrupted current of steam. Therefore if, in such a locomotive, the smallest section is too high above the nozzle, it follows that, under such circumstances the steam does not enter it freely and the entrained air is held back so that the vacuum will be again lowered and the advantage aimed at with the long nozzle distance will be either partially or wholly lost.

VII.—EXPERIMENTS WITH A BRIDGE ACROSS THE NOZZLE.

In the first place, in the latter part of 1891, two four-coupled locomotives with bogie trucks were put in service on the Prussian State Railway, which were at first very poor steamers. An attempt was made to improve them by the use of a wedge-shaped cross-piece, called a bridge, having the sharp edge down.

The result was surprising and brought about a rapid application of the bridge to the large locomotives. The action of the bridge cannot be likened to a similar contraction of the nozzle, for the same thing was accomplished by the introduction of the bridge as is usually obtained in connection with an enlargement of the nozzle. It therefore became necessary to prove the advantage of the bridge on the apparatus to fix the reason for its action and to determine the best form to give it.

In order to shut out, once for all, the plea regarding the contraction of the exhaust nozzle, the same free opening was given to the nozzle with a bridge that the simple nozzle possessed. Fig. 58 shows the form and measurements given to the two nozzles, the breadth of the bridge being 0.63 inch. It was tested with all 18 of the experimental stacks, both full length and repeatedly shortened. The most important result obtained was to show that for stacks of small diameters and short nozzle distances the bridge either made no improvement at all or one that was very slight (see Plate VII., 4, cylinder stacks having a diameter of 13.78 inches), while for greater distances it acted disadvantageously. It is, therefore, of

considerable importance, if the stack is large and not too long and works so much the more, that it should be widened out somewhat at the top. The principal advantage of the bridge is seen to lie in the fact that, for the same amount of work, the necessary nozzle distance can be very considerably shortened. This is especially to be considered in the case of locomotives whose boilers are high, in

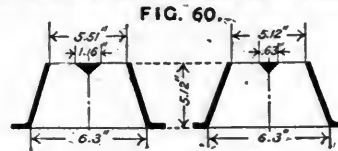


FIG. 60.

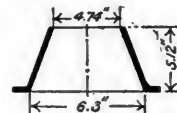
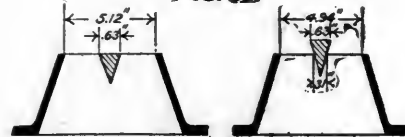


FIG. 61.



FIG. 62.



which the total height of the stack is comparatively short on account of the other conditions surrounding it.

In order to make this perfectly clear, reference is again made to the diagrams of the experiments with funnel-shaped stacks given in Plate VI. under D. Here there are shown the two stacks of 13.78 inches diameter having flares respectively of $\frac{1}{2}$ and $\frac{1}{4}$ as well as the one of 15.75 inches diameter with a flare of $\frac{1}{2}$, each being represented in four different lengths. (It is to be noted here again that 17.52 inches must be taken from the abscissa given in this plate, if we wish to determine the distance of the nozzles from the smallest section of the stack.)

From Plate VI. and VII., it will be seen that a satisfactory action of the bridge is only obtained at certain fixed positions of the nozzle, and that when this distance is increased, the shorter and larger the stack must be made and, above all, the sharper must be the

flare. In order that a comparison may be made of this action for various forms of stacks, the figures for several conical stacks of different diameters and lengths are brought together in Table XXII.

The last column of this table shows very clearly what advantage there is to be gained by the use of the bridge, for it will be seen that in some forms of stack the adjustment of the nozzle position can be shortened 14.17 inches without detracting in any way from the efficiency of the blast. In like manner the action of a locomotive's draft can be considerably increased by the application of the bridge, the position remaining unchanged, and that, too, without contracting the nozzle. If this is not necessary, because the locomotive already makes steam enough, then the stack can be enlarged if a bridge is used. This was practically demonstrated by applications made to six and eight-wheeled engines at the Tempelhof shops. The accompanying Table XXIII,* gives the increase of draft in comparison with an ordinary nozzle, that was obtained on the apparatus with a series of nozzle distances and with different stacks.

We see from this that there are circumstances under which with the same nozzle distance an increase in efficiency of 90 per cent. can be obtained by using a bridge. The most efficient point of action of the bridge of a given diameter, length and sharply contracted stack is also shown.

For the sake of determining the best form, experiments were made with five different bridges. In this work the width was kept the same. First two bridges like those shown in Fig. 59 were tried upon the apparatus; they had a common width of 1.16 inches, and a depth of .30 and .59 inches respectively on a nozzle with a diameter of 5.51 inches. The free sectional area for the passage of the steam was then exactly the same as that previously used in a nozzle 5.12 inches in diameter with a bridge .63 wide and was also the same as that of a simple nozzle 4.74 inches in diameter, as shown in Fig. 60. In all of these experiments it was clearly shown that the stacks, whether their diameter was greater or less, not only produced a lower vacuum with a bridge 1.16 inches wide, but also threw considerably more water than they did with a narrower bridge and a correspondingly smaller nozzle diameter. The jet of steam was consequently too large for the corresponding sectional area of the stack.

The experiments could, therefore, well be limited to bridges .63 inches wide. They were consequently carried on with three different depths, as shown in Fig. 61. In the lowest, having a depth of .31 inches, the apex was a right angle. The results are shown in Plate VII., under II. In that place only five stacks are given, because the ratios of the bridges to each other, as well as to the other forms of stacks, were exactly alike.

(To be Continued.)

New Publications.

THE WISCONSIN ENGINEER. *University of Wisconsin Engineering Journal, Madison, Wis.* Published quarterly; \$1.50 per year. Pages 6½ by 9½ inches.

The first issue of this journal is dated June, 1896, and contains 90 pages of interesting and instructive reading matter covering a wide range of subjects. It also contains an index to current engineering periodicals, embracing the period from Dec 5, 1895, to April, 1896, inclusive. This new engineering index is compiled without any description or digest of the articles mentioned in it, and for that reason we think it will be found to fall short of what is usually required. The titles of some articles are a pretty good indication of their contents, while others are very "non-committal" and need an explanatory note or phrase to enable the seeker after information to judge of the value of the article to him. But it may be that we don't know as much as we think we do about what an index ought to be, and we certainly wish the new enterprise all the success to which it aspires. The articles in its reading pages are certainly of a high standard, and if maintained in succeeding issues will place the *Wisconsin Engineer* among the best of the technical periodicals published in connection with engineering colleges.

AIR BRAKE CATECHISM. By C. B. Conger. Ninth Thousand. *Locomotive Engineering.* New York. 96 pages, 3½ by 6 inches. 25 cents.

That there is a demand for this kind of a book is indicated by the fact that the copy before us is one of the ninth thousand that has been published. As suggested by its title, it is written in the form of question and answer, which has some decided advantages in a book of this kind. It is difficult to understand, though, why writers of this kind of "practical" books omit the definite article. Here is an

example from the book before us, with hyphens inserted where the article has been omitted. "If (—) train pipe leaks (—) brake will continue to set tighter when (—) brake valve is put on l.p. and stop the train before you want it to." There seems to be an idea in some authors of such books that it gives a more distinctly technical character to what they write if the article referred to is omitted.

Some of the engravings in the book are very bad. How any one not familiar with the construction of the engineer's brake valve can learn anything from the smudgy engraving which the publishers have seen fit to put on page 20 any one would be at a loss to know. The lettering too in this illustration is very bad. Another fault is that sometimes as many as three separate inquiries are embodied in one of the questions. A novice cannot easily retain these in his mind so as to understand the following answers. The binding of the book is simply infuriating. The leaves are fastened together with wire, and the publishers ought to provide the reader with a small "jemmy" or "pinch-bar" to pry the leaves apart. The index at the end is unworthy of the name, as it gives only 32 terms with the pages in which they are referred to. In a book of this kind a good index is very essential. In speaking of the book generally it cannot be said that lucidity is one of its marked characteristics. A novice, it is thought, will be puzzled a good deal to understand some of the explanations.

Doubtless the book is more susceptible of understanding when used and read on a locomotive or in the shops where the objects explained can constantly be referred to, than it is when such reference is impossible.

WESTINGHOUSE ELECTRIC STREET CAR EQUIPMENTS. *Containing a Description of the Various Motors, Controller and Other Electric Street Car Apparatus Manufactured by the Westinghouse Electric and Manufacturing Company, with Detailed Instructions for the Operation, Inspection and Repair of same; also Full Directions for Locating and Remedying Faults.* By Frederick L. Hutchinson and Leo A. Phillips, East Pittsburgh, Pa. 91 pages, 4½ by 7 inches. (\$1.)

The sub-title of this book gives a tolerably good idea of its scope and character. In the preface the authors say further that its "object is to give a complete description of the various street-car motors and car equipment apparatus manufactured by the Westinghouse Electric and Manufacturing Company; to give complete directions for the proper inspection and repair of the same; to explain in detail the operations of the various devices, and also to give explicit instructions for locating and remedying any electrical trouble that may be encountered. The writers have endeavored to put all directions, diagrams and illustrations in such form as to be readily understood by any ordinary man, without previous electrical training, and have aimed to give practical rather than theoretical information." The titles of the chapters are "Electrical Units and Terms"; "Description of Westinghouse Street Car Motors"; "Description of Controllers and Other Car Apparatus"; "Operating of the Car Equipment"; "Inspection"; "How to Locate and Remedy Faults"; "Repairs, Rewinding Armatures, etc."

The book is admirably printed, illustrated and bound in limp covers, which invite perusal.

A PRACTICAL HANDBOOK ON THE CARE AND MANAGEMENT OF GAS ENGINES. By G. Liefeld, C. E.; authorized translation by G. Richmond, M. E. (with instructions for running oil engines). Spon & Chamberlain, 12 Cortlandt street, New York. 168 pages. (\$1.50.)

As the name indicates, this book does not dwell upon the theory of the gas engine, but furnishes the reader with practical information on the purchase, installation and operation of this type of motor. The first chapter is on choosing and installing a gas engine, and tells how to judge the design, workmanship, correctness of running, economy, reliability and durability, etc. The items involved in the first cost of a gas engine installation are enumerated, also the items under the expense of operating. The character of the foundations, arrangements of piping and the precautions to be observed in setting up the engine are also discussed in this chapter. The second chapter is devoted to brakes and their use in ascertaining the power of gas engines. In connection with the work of testing the "brake power" and "indicated power" are defined and compared, and the distribution of heat in the gas engine briefly stated. The third chapter is on the attendance on gas engines, and gives instructions on starting, stopping, oiling, cleaning, etc. The next chapter takes up the different kinds of defects that are liable to develop in operation, and tells what should be done in each case. This chapter is quite complete, and is written in a practical vein, as is all of the book, for that matter. It is followed by a chapter on dangers and precautionary measures in handling gas engines. The last chapter is one of 12 pages on oil engines, and is devoted chiefly to the Hornsby-Akroyd engine. The little book will be found of genuine practical value to those operating gas or oil engines, or about to purchase or install them.

* This table we are compelled to omit this month. It will appear in our next issue.—Ed.

Water-Tube Boilers.*

BY J. WATT.

Some years ago the writer had the honor of reading a paper on the subject of water-tube boilers before the Liverpool Polytechnic Society, and, after enumerating the points which constituted a good water-tube boiler, deduced therefrom the following rules or laws, which should be observed in designing a trustworthy steam generator. They were as follows:

1. The tubes should be arranged in a position to absorb the greatest amount of heat, by causing the flame to travel in an upward direction at right angles to their axis.
2. The tubes should be in a horizontal or inclined position, as the most efficient to emit heat.
3. The steam generated should have free and unobstructed escape to the steam receiver.
4. The circulation or supply of water to the tubes must be copious to prevent overheating.

These are the theoretical, and form the essential, conditions of an efficient water-tube steam boiler.

But, in addition to these, there is another not the less important which concerns the practical part or life of a boiler, namely, the facilities for inspection, cleaning and repairing.

It is 22 years ago since the above was written, and, although old, it is quite as applicable to-day as then, and as far as the writer's experience goes, quite borne out by practice.

It is not the writer's intention of going over the whole range of this subject of water-tube boilers, but to lay before you the result of a few experiments, which may elucidate and explain some of the mysterious circumstances connected with this complex subject.

The experiments were made with a small model boiler (see Figs. 1 and 2) containing 39 straight tubes, each $\frac{3}{4}$ inches in diameter by 9 inches long, containing 2.9 square feet of heating surface. The receivers to which the tubes were attached were flat, the end plates were of glass, so that the tubes could be seen right through and the action going on inside could be distinctly observed. A steam receiver was also placed on the top, connecting the two other receivers. Heat was supplied by two Bunsen burners, consisting of two tubes with cross slots, the heating taking place being very much similar to that of an ordinary firebrake burner. The model was so constructed that it could be used or tried in a great number of different positions.

The first series of experiments was made with a view of finding out the relative value of heating surface when the tubes were angled from a horizontal position gradually to that of a vertical one, or through an angle of 90 degrees. The experiments were conducted at atmospheric pressure, and commenced by first raising a

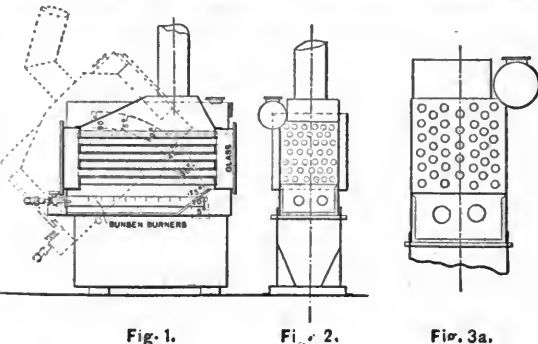


Fig. 1.

Fig. 2.

Fig. 3a.

angle at which the boiler was tried beginning at the horizontal position and gradually rising to the vertical position. It was found when the boiler was angled 10 degrees it gave the best result; therefore 10 degrees represents the maximum evaporation, or 100 per cent.

In looking at this diagram, we find that in any water-tube boiler whose tubes are inclined, say 10 degrees, by merely increasing the angle to 30 degrees the amount of water evaporated is reduced from 100 to 85, or 15 per cent. less. If the angle be increased to 60 degrees the decrease will be 33 per cent.; and at 90 degrees, "or the tubes vertical, the reduction is a little over 40 per cent. This compares very favorably with the old-fashioned rule employed in the ordinary steam boiler of allowing 2 square feet of vertical heating surface to be of equal value to each 1 of horizontal.

These experiments were conducted with the tubes placed in horizontal rows, so as to allow the products of combustion to travel in a zigzag direction to the funnel. The next series were taken with the boiler turned on its side, so as to form the tubes into vertical

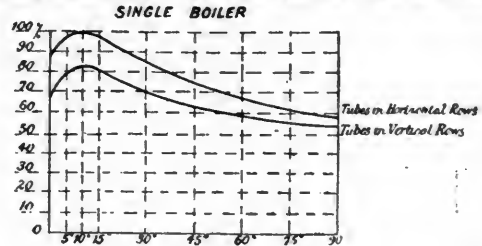


FIG. 3.

rows, and giving the products of combustion a more direct course to the funnel (see Fig. 3a). The result is shown by the lower curve on Fig. 3. The highest percentage was 82 per cent. at 10 degrees and 53 per cent. at 90 degrees, the best result showing a difference of 18 per cent. in favor of the former arrangement of tubes.

Instructive as these tests may be, the next series will show still more striking results. In order to arrive at the duty performed by various tubes or rows of tubes, and more especially those nearest to the source of heat, if we take another boiler—or, rather, a part of a boiler representing that row of tubes which is nearest to the fire—and place the two together, as represented in Fig. 4, we have the means of arriving at the evaporation of each boiler separately. This small boiler consists of six tubes only, having a heating surface of .44 square feet, compared with the larger one of 2.9 square feet, or a combined heating surface of 3.34 square feet.

The results of this arrangement are represented on diagram Fig. 5. The upper curve shows the combined evaporation of both boilers, and although there is an augmented heating surface of about 15 per cent., yet there is very little difference in the amount evaporated. The lower curve shows the evaporation of the original or larger boiler, and we now see that at its best it is reduced from 100 per cent. to 40 per cent. at 10 degrees, and from 60 per cent. to 17 per cent. at 90 degrees. On the other hand, the small boiler is represented by the middle curve, and its evaporation at its best is 60 per cent. at 10 degrees, and 45 per cent. at 90 degrees. The above results may be stated in other words, namely, that practically 60 per cent. of all the steam generated in any water-tube boiler with tubes at any angle is generated in the first or nearest row of tubes to the fire. The remaining 40 per cent. is left for the larger portion of the boiler to accomplish.

By reversing the positions of the two boilers—by placing the smaller on top of the larger one—we can arrive at the evaporation of the top row; but this was found to be so small as not to be taken notice of. The writer had not the means of testing the intermediate rows; but the following table will not be very far off:

1st row nearest to the fire				evaporated 60.0 p. c. of the total evaporation.	
2d	"	"	"	24.0	"
3d	"	"	"	9.5	"
4th	"	"	"	3.5	"
5th	"	"	"	1.5	"
6th	"	"	"	1.0	"
7th	"	"	"	0.5	"
				100.0	

The importance of the above cannot be overlooked. Either the first row is doing too much, or the back row too little; and the conclusion arrived at is that, practically, the first row is receiving the whole wear and tear of the boiler, therefore more

given weight of water to the boiling point, and then ascertaining the amount evaporated after an interval of 15 minutes.

After a few preliminary trials, it was found that when the boiler was angled about 10 degrees from the horizontal the evaporation was highest, viz., $8\frac{1}{2}$ ounces; when the angle was increased to 15 degrees, the evaporation was $8\frac{1}{2}$ ounces; 30 degrees, $7\frac{1}{2}$ ounces, 45 degrees, $6\frac{1}{2}$ ounces; 60 degrees, $5\frac{1}{2}$ ounces; 75 degrees, $5\frac{1}{2}$ ounces; and 90 degrees, 5 ounces. Again on reducing the angle to 5 degrees, the evaporation was $8\frac{1}{2}$ ounces, and when level $7\frac{1}{2}$ ounces. It may be here stated that owing to the pressure of gas varying a little, very seldom the same results could exactly be arrived at, but by making several trials the above is a fair average. This is graphically represented in Fig. 3 (top curve); the vertical ordinates representing the percentage of evaporation at the various

* From a paper read before the (British) Institution of Naval Architects, March 26, 1896.

liable to damage and renewals. This has proved itself in the case of copper tubes, which, although a better conductor of heat than either iron or steel, yet were unable to stand the severe work they had to perform. The danger from overheating and rupture is not only very unpleasant from a stakeholder point of view, but the giving way at some critical moment demands our most important consideration; in short, it is the vital part of the water-tube boiler.

Seeing this difficulty some time ago, the writer devised some means by which the first row was relieved of this heavy duty, and more laid on those immediately behind. This is accomplished by substituting tubes of much larger diameter nearest to the fire than those which are more remote. The larger tubes contain more water, and present less heating surface for the space occupied than those of smaller diameter. The result is that the evaporation is less

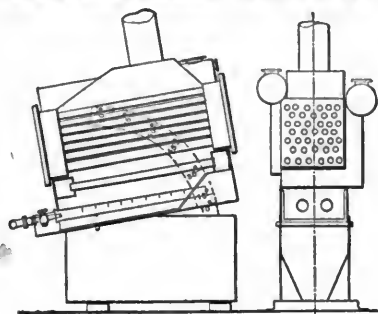


Fig. 4.

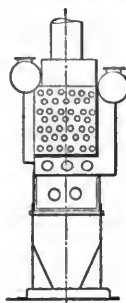


Fig. 6.

with the larger tubes, but greater with the smaller. Fig. 6 represents the arrangement. For the six $\frac{3}{4}$ -inch tubes we now adopt three $\frac{3}{4}$ -inch tubes in their place. The weight of water in the three tubes is double that in the six smaller ones, while the heating surface remains the same. The diagram representing the results of the trials is shown on Fig. 7, the top curve, as before, representing the results of the two boilers. Practically there is very little difference compared with the similar top curves of Figs. 3 and 5; if anything, it is slightly in favor of Fig. 7. But when we come to compare the two lower curves with the similar curves in Fig. 5, we find that they have almost changed places. Taking the top or larger boiler, the evaporation at 10 degrees is nearly 60 per cent. of the total, as compared with a little over 40 per cent., shown on the former trial, the curve dropping down at 90 degrees to 27 per cent., against 17 per cent. Taking the lower boiler, repre-

COMBINED BOILER WITH SMALL BOTTOM TUBES

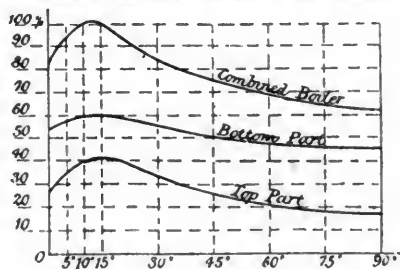


Fig. 5.

sented by the three large tubes, the evaporation is reduced from 60 per cent. to a little over 40 per cent. at 10 degrees with the larger tubes, terminating at 33 per cent. at 90 degrees. It will be observed that the two curves cross each other when the boiler is at an angle of about 55 degrees, showing that the evaporation at this angle is about equal in each boiler. We here see that the evaporation in the first row of tubes is very much reduced, there is less liability to overheating, and accidents are reduced to a minimum.

The quantity of water evaporated by the first row of small tubes was at the rate of 5 pounds per square foot of heating surface per hour, and the velocity at the end of the tubes about 3.8 feet per second. The tubes were full of semi-steam and water, so that no

COMBINED BOILER WITH LARGE BOTTOM TUBES

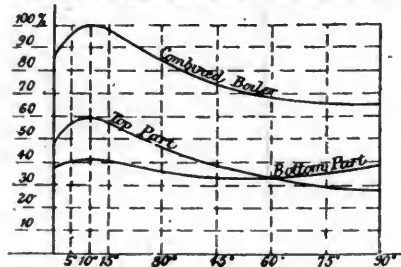


Fig. 7.

light could be seen at the other end; evidently these tubes were evaporating their maximum quantity with efficiency.

On the other hand, with the row of large bottom tubes, the rate of evaporation was about 3.5 pounds per square foot heating surface, and the velocity at the tube ends (steam only) about 2.9 feet per second. Up to an angle of about 60 degrees a light could be distinctly seen through these tubes, the steam occupying about one-third of the area on the top side, the water underneath presenting a clear, solid mass. Above 60 degrees elevation the water and steam became more or less mixed up, so that a light could not be seen at the other end.

It must be remembered that the above trials were made at a pressure of 1 atmosphere where the relative volumes of steam and water are as 1,640 to 1. For higher pressures a corresponding rate of combustion may be adopted.

The most vital parts in any water-tube boiler, and the most easily damaged by overheating, are those tubes in close proximity to the fire. To overcome this difficulty two courses are open—(a) by adopting small tubes and providing for a vigorous circulation; (b) by adopting larger tubes and a less active circulation. Adopting the former, there is a limit both in respect to the speed of the current and the quantity of steam in contact with the heating surfaces. According to Mr. Thornycroft's experiments, at a pressure of 3 atmospheres the relative volume of steam and water passing through a number of $\frac{1}{2}$ -inch tubes was about 5.4 to 1, and at 12 atmospheres this would equal $\frac{1}{2}$ to 1, or three volumes of steam, at an average, in each tube, to two of water, a condition of things which presents to us two evils; one is the danger arising from the tube becoming much hotter than the temperature due to the pressure. As an instance of this, there is the failure of copper tubes in water-tube boilers to stand this excessive heat. The second evil is the slow corrosion taking place, owing to part of the steam in contact with the tube becoming decomposed at a high temperature, forming oxide of iron and hydrogen gas. By the improved arrangement of larger tubes to face the first and direct action of the fire, a larger body of more solid water is in actual contact with the heating surfaces; the liability to damage by overheating is reduced to a minimum; the duty of the various tubes more evenly distributed, and the steam generated more freely disengaged.

In conclusion, there is one point which, during the time these experiments were being made, confirmed the writer's views more strongly of a grave defect in Belleville water-tube boilers for marine purposes.

The arrangement of all water-tube boilers with horizontal or slightly inclined tubes, on board ship, should be parallel with the line of keel. But it appears to be the rule, so far as this boiler in question is concerned, to place the same across the ship. Now, the inclination or angle of the Belleville boiler tubes is about 2 degrees or 3 degrees from the horizontal, and as 10 degrees, say, is not an uncommon angle for a ship to roll at sea, it follows that the tubes will become depressed, or angle reversed, to the extent of 7 degrees or 8 degrees.

A ship to roll from eight to ten rolls per minute is not uncommon, and therefore six or eight seconds would be the duration of one roll.

Now, imagine the ship rolling, a heavy fire on the grate, and in this time these lower tubes, generating, as we have seen, such a large volume of steam, which would immediately reverse the circulating current, fill the upper ends, and be here imprisoned, only to be relieved by the next roll. The greater portion of the steam will now be transferred to the other end, to be again re-imprisoned, and so on until the ship gets into least turbulent waters. With reference to what the continued effect on these semi-dry tubes would be in a sea way, or in the event of the ship having a list, the result is left for your better and impartial judgment.

The Eighth Statistical Report of the Interstate Commerce Commission.

The advance sheets of the eighth statistical report of the Interstate Commerce Commission have been received. Although hoary with age, relating as they do to the year from July 1, 1894, to June 30, 1895, we will follow the custom of quoting a few of the figures.

On June 30, 1895, 169 roads, operating 37,855 miles of track, were in the hands of receivers, 23 roads and 2,903 miles less than 12 months previous. The total mileage in the United States on that date was 180,657.47 miles. During the year covered by the report 14 roads were abandoned, 9 merged, 32 re-organized, and 23 consolidated. There was on June 30, 1895, 1,965 railway corporations of which 1,013 maintained operating accounts. The total number of locomotives in service were 35,699. Of this number 9,999 were passenger locomotives, 20,012 freight locomotives, 5,100 switching locomotives and the remainder unclassified.

The total number of cars reported was 1,270,561, of which 33,112 were passenger cars, 1,196,119 were freight cars, and 41,330 were used by the roads in their own service. These figures do not include private car-line equipment. The number of passengers carried per passenger locomotive was 50,747, or 3,907 less than in 1894. The number of passenger-miles per passenger locomotive was 1,218,967, or 225,433 less than in 1894, while the number of passenger cars per 1,000,000 passengers carried was 65, or 12 greater than the preceding year. This is probably largely due to decreased travel on account of business depression, but it also suggests that passenger traffic has returned to its normal condition previous to the World's Columbian Exposition. The number of tons of freight carried per freight locomotive in 1895 was 34,817, showing an increase of 2,908 when compared with the corresponding figures for

1895, were \$1,075,371,462. The expenses of operation for the same period were \$725,720,415, which were \$5,693,907 less than for 1894. The important unit in railway statistics designated as the coefficient of operating expenses, that is, the percentage of operating expenses to operating income, for 1895, was 67.48 per cent. The amount of railway capital on June 30, 1895, is shown to be \$10,985,263,125, or \$63,330 per mile of line. The increase during the year was \$188,729,312.

The number of railway employees killed during the year was 1,811, and the number injured was 25,696. The number of passengers killed was 170, the number injured, 2,375. One employee was killed for each 433 employed, and one employee was injured for each 31 employed. Of the class of employees known as trainmen, that is, engineers, firemen, conductors and other employees whose service is upon trains, it appears that one was killed for each 155 in service, and one injured for each 11 in service. The number of passengers carried for each passenger killed during the year was 2,984,832, and the number carried for each passenger injured was 213,651. The liability of passengers to accidents is better shown in the fact that 71,696,743 passenger-miles were accomplished for every passenger killed, and 5,131,977 passenger-miles for every passenger injured.

Double Cylinder Boring Machine.

The machine shown herewith is designed for rapidly boring two cylinders at once. It is peculiarly useful in works where a large number of cylinders of the same or nearly the same size are to be bored. The machine is usually made with a bed 11½ feet long, fitted with a head stock carrying two heavy spindles 5 inches to 9 inches in diameter with bearings adjustable for wear, placed with their centers 31 inches apart horizontally. These spindles are driven by a 30-inch cone pulley with four steps for 3-inch belt, geared 15 times. The boring bars are inserted in these spindles and have their outer ends supported in a double tail stock fitted with removable bushings and adjustable upon the bed.

The work table is 66 inches by 43 inches, which dimensions, however, can be varied when required. The table traverses by hand or power, 45 inches upon the bed. It has four automatic feeds ranging from $\frac{1}{32}$ to $\frac{1}{8}$ of an inch. These feeds can be changed at slight expense to any desired figures, and the bed can be lengthened or shortened within reasonable

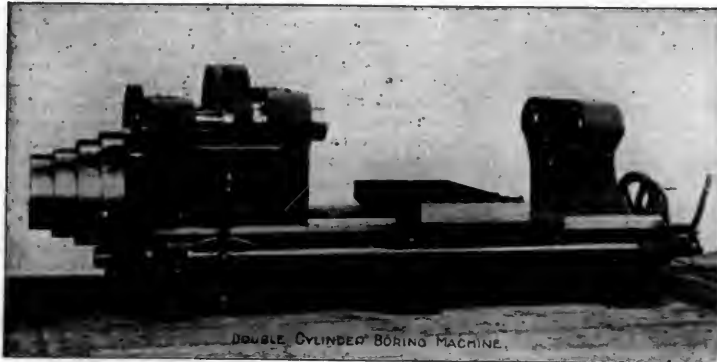
limits, to suit requirements. From the top of the table to the center of the spindles is 18 inches, and the bed is 5 inches below the top of the table. The total swing over the bed is 48 inches, and over the table 38 inches.

This special machine has been designed by Messrs. Bement, Miles & Company, of Philadelphia. It is particularly useful in shops where large numbers of small cylinders are being manufactured. One of these machines has lately been installed in shops where they are manufacturing air compressors, rock drills and similar work. It has proven in this connection very efficient and satisfactory.

A New Dynamometer.

Consul Doederlein, of Leipsic, calls attention to a new dynamometer invented by Mr. von Pittler, in Germany. This dynamometer, so it is claimed, is of equal value as an instrument for power lessors and power lessees. The construction is extremely simple, as all delicate parts are excluded. It is available as an independent apparatus for the measurement of power, either of individual machines or of a whole establishment. It can, furthermore, be used as an intermediate countershaft, and is, as such, in addition to its qualities as a dynamometer, an excellent elastic impulsion, especially for electric motors.

Just in the same way as this dynamometer can be used as a countershaft, it can also be connected with the shafting. The actual cost is so low that we must regard it, on account of its



Double Cylinder Boring Machine.

1894. The number of ton-miles per freight locomotive was 4,238,821, the increase over the previous year being 242,068. These figures indicate increased economy in transportation of freight. The same result is shown by the fact that 1,888 freight cars were required to move 1,000,000 tons of freight in 1894, and 1,717 in 1895. These figures, however, are not satisfactory, because the basis of the computations does not include cars not owned by railway companies, in which a large proportion of freight is transported.

Out of a total equipment of 1,306,260 locomotives and cars, only 362,408 were fitted with train brakes, and 408,856 with automatic couplers on June 30, 1895. The increase in equipment fitted with train brakes was 31,506; with automatic couplers, 51,235. On June 30, 1895, the number of passenger cars in service was 33,112, of which 32,384 were fitted with train brakes, and 31,971 with automatic couplers. The number of freight cars in service was 1,196,119, of which 295,073 were fitted with train brakes and 366,985 with automatic couplers.

The number of men employed by railways shows an increase of 5,426, as compared with last year, the number of employees being 785,034 on June 30, 1895.

The number of passengers carried by the railways during the year ending June 30, 1895, was 507,421,362. The number of passengers reported as carried one mile was 12,188,456,271. The number of tons of freight carried as reported by railways was 603,761,171. The number of tons carried one mile was returned as 85,227,515,891, indicating an increase of 4,892,411,189.

The gross earnings of the railways for the year ending June 30,

good qualities, as a necessary part of a shafting—as a part that everybody in possession of a mechanical motive power must of necessity have, if he desires to utilize such power to advantage. The dynamometer can be easily handled and controlled by anybody, whether expert or layman.

The consumption of motive force, be it fuel (in the shape of coal, steam, hot air, oil, etc.), water power or electricity, can be controlled per absorbed power unit, so that both power lessor and power lessee can check off the consumption of power at any time, say weekly, monthly or yearly, in the most precise manner.

It has also been observed by Mr. von Pittler, by means of his apparatus, that the amount of labor performed in his factory each day from 7 to 9 o'clock a. m. was proportionately less than from 9 to 12 o'clock a. m. It was found that this difference was due to the fact that the foreman came to the factory at 9 o'clock. Again, the record kept by Mr. von Pittler shows that the amount of labor on Fridays, Saturdays and Mondays was 800,000 meter kilograms less than other days, whereas on Thursday—the day before pay day—the largest amount of labor was performed.

Mr. von Pittler, who has the counting apparatus adjusted to one side of his office desk, thereby keeping control over the work of his machines, can also very easily ascertain the difference in the amount of coal used before and after cleaning the boilers.—*U. S. Consular Notes.*

The Origin of the Word Derrick.

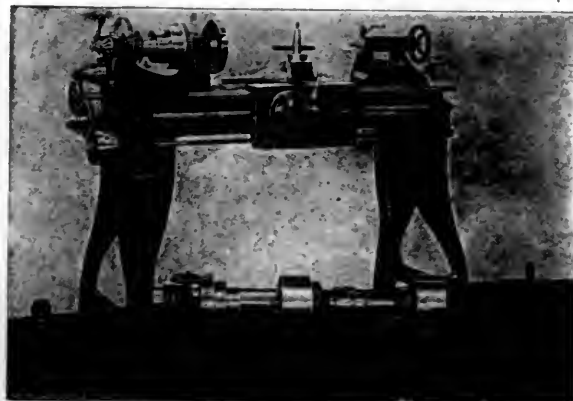
How many mechanics or engineers have ever heard how this word originated? The following is taken from an "exchange":

"In mechanical matters the name of the familiar 'derrick,' a very common form of crane, has not the most honorable pedigree. Derrick was indeed nothing more exalted than the Tyburn hangman of the early part of the seventeenth century, and his name figures frequently in plays of the period. For more than a hundred years he gave his name to gibbets, whose 'elevating' powers were applied in a more useful direction in the modern 'derrick.'"

Webster says the word originally meant a gallows, from a hangman named *Derrick*.

The Wagner 12-Inch Lathe.

The accompanying illustration is of a 12-inch lathe built by the A. P. Wagner Tool Works, Sidney, O. This firm build a line of lathes similar to this one in sizes from 8 to 18 inches. They are strong and well built, and the makers claim they are second to



12-in. x 4 1/4-ft. Bed Screw and Rod Feed Lathe with Three-Speed Cone.

none in the market. The head stocks and tail stocks are not cored out at all, but are solid. The spindles are of the best hammered steel, accurately ground, and they run in phosphor bronze bearings. The reverse and cone gear are cut out of solid steel. The carriage is gibbed front and back and has extra large bearings its entire length, and is arranged for side facing. All sliding parts are accurately scraped to a bearing. The 12-inch lathes are furnished complete with steady rest, large and small face plates, centers finished drop-forged, and a full set of standard change gear; also

with a plain rest, a compound rest, plain foot power or bicycle foot power, friction countershaft or plain countershaft. Some of the important dimensions of the 12-inch lathe are as follows:

Swings over bed	13 inches
Swings over carriage	8 1/2 inches
Swings over plain or compound rest	7 1/2 inches
Diameter of three-speed cone	6 1/2, 4 1/2, 3 inches
Diameter of four-speed cone	6 1/2, 4 1/2, 3 inches
Width of belt on cones	2 inches
Diameter of head spindle	1 1/2 inches
Hole through spindle (standard)	1 1/2 inches
Front bearing of spindle	1 1/2 by 3/4 inches
Back bearing of spindle	1 1/2 by 3/4 inches
Diameter of tail spindle	1 1/2 inches
Will cut screws	2 to 40 threads per inch
Will cut pipe threads	1 1/2 threads per inch
Speed of countershaft	180 revolutions
Size of countershaft pulleys	8 by 4 inches
4 1/2-foot lathe takes between centers	24 inches
Weight of 4 1/2-foot lathe for domestic shipment, about	1,050 pounds
Weight of 4 1/2-foot lathe for foreign shipment, about	1,150 pounds
Beds made in lengths of	4 1/2, 5 1/2, 6 1/2 feet

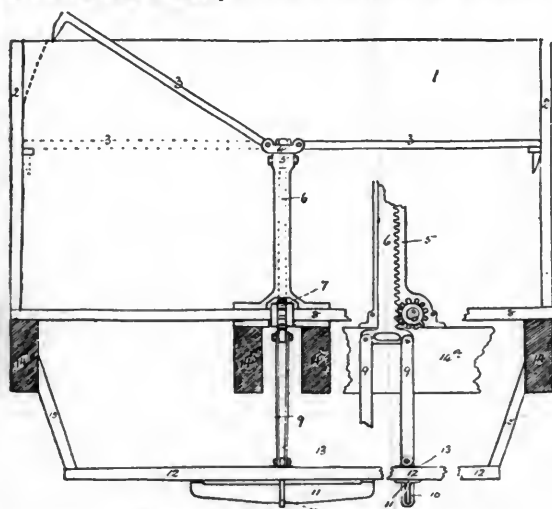
This company has an entirely new plant heated by steam and lighted by its own electric-light plant. All its machinery is modern, and the excellent facilities are supplemented by a rigid inspection of all work. The concern also builds a full line of plain and automatic turret lathes.

Its new catalogue, just issued, is printed in English, German, Spanish and French, and will be sent on application. The orders this company has received for its machines are so numerous that it is running its works double time.

The Fader Dump Car.

The Fader device for operating the drop doors of a hopper-bottom car is shown in the accompanying drawing. It can be readily fitted to any ordinary hopper-bottom car without material alteration of the car. The chains by which the doors are usually operated being removed from the shaft, a small cast-steel toothed-pinion is keyed to it in the center, between the center sills of the car; against this, traveling vertically between the sills is a cast-steel toothed-rack, to the lower end of which are attached parallel links of such a length as just to touch the inner face of the doors when closed. Along the outer face of the two doors are two cross-bars of flat bar-iron, about one-half of the length of the doors, and supporting the latter at their extreme ends; passing through the doors are two links which pass around these cross-bars and connect them with the lower ends of the longer links. By this arrangement the weight of the doors and the load is at twice as many points as would be the case if the links were directly connected to the doors.

Fitting over the rack and pinion and acting both as guide and stop to the former is a case of malleable iron bolted to the sills of the car. This case is made in halves, so that either part may easily be removed when necessary.



Fader's Dump Car Mechanism.

- | | | |
|-------------------|-----------------------|----------------------|
| 1. End of car. | 7. Pinion. | 12. Drop-doors. |
| 2. Sides of car. | 8. Rack. | 13. Washer plates. |
| 3. Cross binders. | 9. Links. | 14. Outer sills. |
| 4. Swivel. | 10. Connecting links. | 15a. Center sills. |
| 5. Rack-case. | 11. Cross bars. | 15. Sides of hopper. |
| 6. Rack. | | |

At the top of the rack-case is the square head of a bolt to which is fastened a swivel with two long wrought-iron cross-binders (or arms with hooked ends) hinged to it, designed to engage in eyes fixed to the inner surface of the sides of the cars, to prevent their bulging when loaded with coal or material of a like nature. When the car is loaded with lumber, or any material not liable to cause bulging, the cross-binders may be unhooked, the swivel turned round longitudinally in the cars and the arms thrown upright across one another (for which purpose they are each provided with a slight off-set), or they may be allowed to hang down between the twin longitudinals; in either case they are well out of the way and occupy but little space in the car. The ratchet and pawl and wrench now in use may still be utilized.

Some of the special features claimed for the car are: 1. Though the power is applied centrally the weight of the doors is divided equally between two points at or nearly opposite the hinges. 2. In case of the doors being jammed or frozen together it is possible to force them down from the interior, the downward movement of the rack transmitting a similar movement to the bar-links which rest on the inner surface of the doors. 3. The removable cross binders supply the advantage of fixed cross-beams without being in the way when the cars are required to be loaded with lumber and other material necessitating the use of the full length of the car. 4. The rack and pinion are well protected from dust or anything that might in any way impair the efficient working of the device; none of the working parts are exposed, and they are not, therefore, liable to get out of order.

Further information is obtainable from M. E. Bourne, Vancouver, B. C.

The Franklin Institute has awarded the Pantasote Leather Company, of New York, the Edward Longstreth Medal of Merit for the excellence of "pantasote" as a substitute for leather in many of its uses.

It is stated that the new gas engine, upon which experts in the employ of Mr. Westinghouse have been working, is now about perfected and its manufacture will be pushed by the Westinghouse Machine Company.

The Buffalo, Rochester & Pittsburgh will erect at Du Bois, Pa., new car shops consisting of a mill building 60 by 200 feet; engine house, 60 by 125 feet; blacksmith and machine shop, 40 by 50 feet; storehouse, 48 by 80 feet, and paint shop, 24 by 96 feet.

The Pittsburgh Reduction Company, of Pittsburgh, Pa., recently rolled some aluminum plates 94 by 94 inches, for the United States government. One of the sheets after rolling was 150 by 100 $\frac{1}{2}$ inches, which is said to be the largest sheet of aluminum ever rolled.

The Stillwell-Bierce & Smith-Vaile Company, of Dayton, O., has closed a contract, amounting to nearly one half a million with a Montreal company for water wheels. It includes 34 wheels, and 21,000 horse power generated is to be conveyed electrically to Montreal.

An attempt is being made to reorganize the Rhode Island Locomotive Works, of Providence, R. I., which closed down last month for an indefinite period. The concern has been for some time in the hands of a committee of the creditors. The contracts which the company had are completed and the committee ordered the shutdown.

The Carnegie Steel Company have placed with the Westinghouse Electric and Manufacturing Company an order for a complete electrical equipment for the Duquesne works. Power will be supplied for all light cranes, etc. There will be 16 large dynamos at the start and the installation will be so made as to permit of adding to it readily.

The Westinghouse Electric and Manufacturing Company has received a contract from the Baltimore, Cantonville & Ellicott City Railway Company for 32 100-horse-power and 20 30-horse power electric motors for its new railway. The heavy motors will be used between Baltimore and Washington and the smaller ones for shorter runs.

The Brown Hoisting and Conveying Machine Company, of Cleveland, O., have received an order from Friedt, Krupp, at Essen, Germany, for a complete hoisting and conveying plant for its blast furnace at Rheinhausen. This plant consists of three electrically operated Brown overhead bridge tramways, each machine having independent winding drums and motors. The company is to furnish all the working parts, including everything but the bridges proper, which will be built in Germany.

The Babcock & Wilcox Company write us as follows: "It having come to our notice that various parties are offering to build what purports to be Babcock & Wilcox boilers, we wish to notify all whom it may concern that no outside concern has been authorized to build our boilers. Without infringing a large number of patents owned by us no one can build other than a very antiquated form of Babcock & Wilcox boilers, and buyers are warned to be on their guard in dealing with anyone who offers them."

Mr. Quayle, Superintendent Motive Power of the C. & N. W. Railroad, expresses himself as being well pleased with the Sall Mountain asbestos as a lagging for his locomotive boilers. Having used it for a year with the best results as far as shown, he is now using it in its natural state for packing around cylinders and steam chests and in other places on his locomotives to prevent radiation of heat and condensation of steam. He is also making quite extensive use of it for stationary work.

Last month H. K. Porter & Company, of Pittsburgh, received orders for engines from foreign companies amounting to between \$30,000 and \$40,000. One of these engines is for a Russian railroad near St. Petersburg, where the engine is to compete with German engines. The engine will have a gage of but 29 $\frac{1}{2}$ inches. A standard locomotive has also been ordered for San Salvador, Central America, and one is being built to haul asphalt at Trinidad, in the West Indies. A 30-gage engine is being built for a tramway at Port au Prince, Hayti, and two 40 ton locomotives are being constructed for use in the gold mines in South Africa, near Johannesburg. An experimental engine will also be built for use in Tiflis, in the Caucasus Mountains.

The electric locomotive exhibited by the General Electrical Company at the Chicago Exposition in 1893, which had a rated drawbar-pull of 7,000 pounds, has been purchased by the Manufacturers' Street Railway Company of New Haven, Conn. It is equipped with air-brakes and its total weight is 30 tons. It will be used to haul freight cars from the junction of the New York, New Haven & Hartford Railway at Cedar Hill, which is about one mile from the New Haven passenger depot, to the works of numerous manufacturing establishments located along the water front at some distance from the freight yards of the "Consolidated" road. The length of the line along which this locomotive will run is nearly two miles, the maximum grade being about 2 $\frac{1}{2}$ per cent.

Mr. Willis Shaw, 506 New York Life Building, Chicago, Ill., has just issued a catalogue of second-hand machinery of various kinds, which he has for sale and which are ready for prompt shipment. There are 20 pages in the catalogue and the machinery listed includes air compressors, air receivers, blowers, boilers, suspension cableways, contractors' dump cars, stone cars, channelling machines, hoists, derricks, ditching machines, drills, dredges, engines of various kinds, locomotives, ore crushers, pile drivers, cast-iron and steel pipe, contractors' plows, pumps and pulsmeters, rails, road rollers and many others. All this machinery is stated to be in good condition and ready for service. Most of it is comparatively new and may be inspected in Chicago. Mr. Shaw is also ready to furnish new equipments. Copies of the list or catalogue will be sent on application.

The Monash-Younker Company, 203 South Canal Street, Chicago, Ill., has lately been incorporated for the manufacturing of steam and water specialties. The new company owns and controls all the specialties manufactured by the Van Auken Steam Specialty Company (mentioned several times in these columns), who will continue to manufacture their specialties, but those goods will be sold through the new concern, the Monash-Younker Company. This new company has also purchased the patent and plant of the Star Coupler Company, of St. Louis, and will manufacture Star lead pipe couplers and fittings for lead pipe plumbing without soldering or wiping a joint. Parties interested in high grade steam specialties or the new method of doing lead pipe plumbing without soldering or wiping joints should address The Monash-Younker Company for their catalogue and mention this journal.

Quite in contrast with the general dullness is the unusual activity displayed at the works of the Link Belt Machinery Company, Chicago, who have been operating their machine shop with two gangs of men both day and night during the past three months. The foundry is also being worked to its limit, one order for castings alone requiring 987,000 pounds of iron. A notable order is that for furnishing the Chicago Sugar Refinery with a complete equipment of machinery for handling coal from cars to iron bins located over 25 Babcock & Wilcox boilers in the power-house. From these bins, whose storage capacity is 650 tons, the coal is

spouted directly on to chain grates under the boilers. An order for the Huron Iron Company, Michigan, for two 8-foot, spirally grooved hoisting drums, together with a 11½-inch by 25-foot shaft, friction clutches, base plates, etc., and brake bands for running the drums independent of each other, both for hoisting and lowering, is nearing completion. The two friction clutches and brake bands are so arranged that they can be operated by one man without moving from one place to another, the operating mechanism being brought to the center of the frame.

The Westinghouse Electric and the Baldwin companies are to build a 75-ton electric locomotive for the Wheeling system of electric roads. This system comprises an underground conductor, a series of buttons projecting slightly above the surface of the pavement between the tracks, and electro-magnetic switches to energize the buttons as the car passes over them. The electricity is taken from the buttons by long collecting bars suspended under the car. To start the car a current from a battery is sent through the collector bars and the buttons in contact with them. This current passes through a magnet in the switchbox under the buttons and raises an armature and brings into contact two sets of carbon discs. The current from the underground feeder wire now passes through the carbon contacts and thence through a coarse coil on the magnet, thereby assisting in holding the switch closed, and thence to the motors by means of the positive contact button and the corresponding collecting bar. From the motors the current passes to the rails or ground as usual. As the car advances the two collecting bars come into contact with the next group of buttons and the process is continually repeated. As the bars leave a set of contact buttons that particular circuit is open, the magnet armature falls by gravity, thus opening the switch and disconnecting the feeder from the positive button. Thus all the buttons are "dead" excepting those directly under the car. This is the system which the Westinghouse Company has adopted and on which so much practical experiment has been lavished.

The new large works of the Q & C Company, manufacturers of railway supplies and special machinery, which has recently been erected at Chicago Heights, a suburb of Chicago, is kept quite busy on orders for the well-known goods made by this company. They have recently secured orders for six large metal sawing machines, a number of which will carry saw blades 36 inches in diameter, and all but one of these machines are to be run by electric motors. The Bryant patent metal saw, as manufactured by this company, requires such a small amount of power to operate successfully that there is a growing demand for these machines equipped with motors, as the saving in actual cost for operation is considerable, at the same time giving equally efficient results. In addition to orders being received for their metal sewing machines, there is no lack of business in their railway equipment and tieplate departments. The output of the Service plate alone this year will aggregate many millions.

The company is constantly receiving testimonials to the excellence of their sawing machines. One party says: "We now have in our works one No. 10 and one XX Bryant Sawing Machine. Our Superintendent is highly pleased with both. They do good work, they do a good deal of work, and do it very nicely, and do not require a skilled workman to operate them." Another says: "Have had one of your No. 10 Sawing Machines since April, 1892, and an XX Cold Saw for nearly two years. Both machines are in almost constant use and are giving us entire satisfaction." A third party says: "I have had it in use continually for nine months with the exception of intervals of a few days. I can cut a 70-pound steel rail in from 12 to 13 minutes, and have made cuts from ¼ inch upward. I have had it in constant use for one and one-half days at a time before getting saw sharpened." Still another writes: "I secured this machine some two years ago and have not bought a set of crossings for renewals since. I usually make card template of the angular joint to be renewed and have it sawed and drilled at my supply yard or let foreman do it on the ground. I consider this saw the best money saving appliance I have on my division. The average time required to cut, say an angle of 45 degrees, is about 20 minutes."

New England Resorts via the Boston & Maine Railroad.

To travel is a pleasant and profitable diversion, and New England, with its widely varying interests, is a region through which one may tour indefinitely, and no matter which way you tour pleasing and interesting sights are always to be found.

The White Mountains of Northern New England are marvelously attractive, and the "Notch," the "Flume," the "Glen" or the Sum-

mit" are but a few of the many features of this wonderful region which you should visit. To one sojourning hereabouts many drives or walks over mountain and dale may be taken, reaping a harvest of pleasure unequalled in these parts; likewise the opportunities for enjoyment that are afforded at the beach resorts are manifold, and the bathing, boating and fishing facilities attract many vacationists.

In no other region can you find so comfortable quarters as those of the hostleries of Northern New England, which are home-like and commodious. The cuisine is invariably of the best, and the service fully equal to that of the metropolitan hotels.

During the summer season the Boston & Maine Railroad sells round-trip tickets to all mountain, seashore and lake resorts of Northern New England and the Maritime Provinces, at reduced rates, and the excursion book which is issued by the General Passenger Department of the Boston & Maine, and which is sent free of expense to applicants, includes a complete hotel and boarding-house list, together with routes and rates to all principal points.

Our Directory

OF OFFICIAL CHANGES IN AUGUST.

We note the following changes of officers since our last issue. Information relative to such changes is solicited.

Baltimore & Ohio.—D. C. Courtney is Division Master Mechanic at Grafton, W. Va., vice Mr. S. A. Souther.

Chicago, Kalamazoo & Saginaw.—Mr. Ed. Woodbury, of Kalamazoo, has been elected President.

Chicago, Hammond & Western.—General Manager J. P. Lyman has also been elected President.

Chicago Rock Island & Pacific.—A. L. Studer, Master Mechanic at Stuart, Ia., has been transferred to Trenton, Mo., on the Southwestern Division, and Mr. J. B. Kilpatrick, at Valley Junction, Iowa, has his jurisdiction extended over the West Iowa Division.

Columbus, Hocking Valley & Toledo.—N. Monsarrat has been elected Vice-President.

Columbus, Sandusky & Hocking.—W. E. Guerin is elected President and Charles Parrott Vice-President.

Denver, Lakewood & Golden.—Wm. W. Borst has been appointed receiver.

Duluth & North Dakota.—H. Fegraus, of Duluth, has been appointed Chief Engineer.

Galveston, Houston & Henderson.—Mr. F. P. Olcott has been elected President and Mr. J. H. Hill General Manager.

Galveston, Lea Porte & Houston.—S. R. Tuggie has been appointed Superintendent of Motive Power.

Great Northern.—General Manager Chas. Warren has retired. Mr. J. M. Barr, General Superintendent, has been assigned some of the duties heretofore performed by the Manager and the office will be abolished.

Green Bay & Western.—Mr. J. A. Jordan has been elected Vice-President.

Gulf, Colorado & Santa Fe.—Mr. L. J. Polk has been appointed Acting General Manager, vice Mr. B. F. Yoakum, resigned.

Kansas City, Fort Scott & Memphis.—Vice-President Ed. S. Washburn has been elected President of this road and also of the Kansas City, Memphis & Birmingham.

Kansas City, Fort Scott & Memphis.—Mr. D. W. McLean, Master Car Builder at Fort Scott, died last month.

Marietta & North Georgia.—Joseph McWilliams is General Manager, with office at Marietta, Ga.

Michigan Central.—Mr. S. B. Wight is Assistant Purchasing Agent with office at Detroit.

Oregon Central.—J. T. Walch has been appointed Master Mechanic and Master Car Builder.

Oregon Railway & Navigation Company.—Mr. Edwin McNeil has been elected President of the reorganized company.

Plant System.—Mr. Wm. Rutherford, Superintendent of Motive Power, has resigned.

Pittsburg, Chartiers & Youghiogheny.—J. M. Schoonmaker has been elected President, vice J. H. Reed, resigned.

Rio Grande & Eagle Pass.—Miss Mary Powers is Purchasing Agent with office at Laredo, Tex.

St. Louis, Chicago & St. Paul.—C. Millard has been appointed Chief Engineer with office at Springfield, Ill.

St. Louis Southwestern.—J. M. Scrogin is Master Mechanic at Tyler, Tex.; vice Mr. Thomas Irglia, deceased.

St. Louis & San Francisco.—Purchasing Agent E. T. Smith has resigned, and the office is abolished. General Manager Yoakum will purchase all supplies.

Sonora Railway, and New Mexico & Arizona.—E. P. Ripley has been elected President.

Southern.—W. A. Walden has been appointed Master Mechanic at Burlington, N. C., to succeed T. S. Inge, transferred to Columbus, S. C.

Texas, Sabine Valley & Northwestern.—R. B. Levy, Sr., has been appointed Receiver, vice L. H. Hart, resigned.

Texas Trunk.—Mr. William White, Superintendent, has been appointed Receiver to succeed Mr. G. T. Atkins, resigned. Office, Dallas, Tex.

Washington & Columbia River.—J. Evans has been appointed Master Mechanic, vice Wm. Saxton, resigned.

AMERICAN ENGINEER CAR BUILDER AND RAILROAD JOURNAL

OCTOBER, 1896.

THE ALTOONA SHOPS OF THE PENNSYLVANIA RAILROAD.

IV.

(Continued from page 206.)

A systematic description of the shops at Altoona, and of what they contain, would not be easy to write. In fact it would be difficult to devise a comprehensive system, or skeleton, for a complete description. As no attempt at completeness is aimed at in these articles, it will not be necessary to follow any particular method in writing or arranging them—all that will be attempted will be to note and describe the various interesting features which the writer had the opportunity of observing, aiming only to make the descriptions easily comprehensible by the reader.

CHILLED CAST-IRON TOOLS.

The use of chilled cast-iron tools in these shops for lathes, planers and boring machines will probably be a novelty to many of our readers, as it was to the writer. These are used for turning, boring and planing both wrought and cast iron and brass. It is found that they will not stand the service of cutting steel, as the cast iron has not sufficient strength to resist the strain, and the cutting edges of the tools crumble in doing that kind of work.

These tools are cast from the ordinary iron used for making chilled wheels, the point or cutting end being chilled, and then

ground in the usual way. It is said that they stand equally as well or better than steel tools do, and are very much cheaper, and are cast in exactly the right form required, and being made from a pattern, are uniform in shape and size.

The various kinds which are made and used are shown in the engraving herewith, Fig. 1, which was reproduced from a photograph, and the list of sizes will indicate the uses in which they are employed.

PNEUMATIC ASH-HOIST.

The economical handling of ashes from locomotives is a problem on which a great deal of thought and ingenuity has been exercised. At Altoona several pneumatic ash-hoists have been designed and erected, and are now working very satisfactorily. The latest of these is illustrated in Fig. 2 and, as will be seen, consists of an iron frame resembling a gallows, with capacity for hanging half-a-dozen culprits at once. The frame extends across three tracks. The view shown in Fig. 2 was taken from a point near the westerly door of round-house No. 3, the latter being behind the observer.* A part of the sand-house, which is indicated in the plan, is shown on the right side of the engraving. The track on which the engine is standing leads directly into the round-house. It will be seen that this track has a pit underneath and in front of the engine. The bottom of this pit has a narrow-gage track on which small trucks run and carry what may be called bifurcated buckets to receive the ashes as it is removed from the ash-pans of the engines.

The tops of two of these buckets are shown in the pit, and one is suspended over the car, alongside of the engine, with its two halves opened, to deliver its contents into the car below. When an engine is to be de-ashed—to coin a word—one of the trucks with a bucket on it is run under the engine, and the ashes are raked out of the ash-pan into the bucket. After it is filled either the engine can be run forward or back, so that the bucket can be reached by the hoist, or if the engine is not below the hoist when

* The round-house is shown in the plan published last month, page 204.

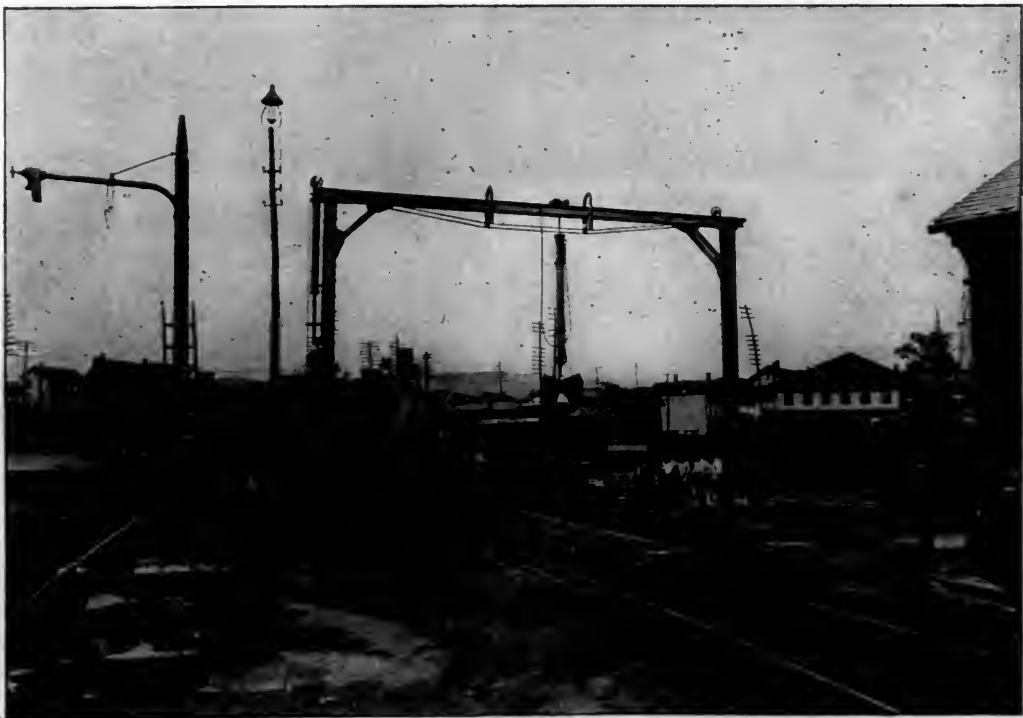


Fig. 2.—Pneumatic Ash Hoists in the Altoona Yard of the Pennsylvania Railroad.



LIST OF CAST-IRON TOOLS.

I. Round nose for iron and brass.....	1 3/4 in. x 5/8 in. x 8 1/2 in.	XXIV. Right hand side or facing tool for lathe	1 3/4 in. x 5/8 in. x 8 in.
II. Thread tool for wrought and cast iron...	1 3/4 in. x 5/8 in. x 8 1/2 in.	XXV. Square nose for planer.....	1 3/4 in. x 1 1/4 in. x 11 1/4 in.
III. Diamond point "right hand" "lathe"...	1 3/4 in. x 5/8 in. x 8 1/2 in.	XXVI. Diamond point for lathe.....	1 3/4 in. x 5/8 in. x 6 3/4 in.
IV. Diamond point side tool, "right hand"	1 3/4 in. x 5/8 in. x 9 in.	XXVII. Diamond point for lathe or planer ..	3/4 in. x 1 1/4 in. x 8 1/2 in.
V. "lathe" point side tool "right hand"	1 3/4 in. x 5/8 in. x 9 in.	XXVIII. Diamond point for planing and facing	1 1/2 in. x 1 3/4 in. x 9 1/2 in.
VI. Round nose for lathe or planer	1 3/4 in. x 5/8 in. x 9 in.	XXIX. Diamond point for planer or facing	1 3/4 in. x 1 3/4 in. x 9 1/2 in.
VII. Square " " planer.....	1 3/4 in. x 1 1/4 in. x 10 1/4 in.	XXX. Square nose for turning cylinder	1 3/4 in. x 1 3/4 in. x 9 in.
VIII. Round " " lathe.....	1 3/4 in. x 5/8 in. x 10 in.	XXXI. Side tool for axle lathe or planer	2 in. x 1 in. x 14 1/2 in.
IX. Round " " or planer.....	1 in. x 1 1/4 in. x 10 1/2 in.	XXXII. Diamond point for axle lathe or planer	2 in. x 1 in. x 15 in.
X. Square " " ".....	3/4 in. x 1 1/4 in. x 11 1/4 in.	XXXIII. Side tool for axle lathe or planer.....	2 in. x 1 in. x 14 1/2 in.
XI. Diamond point for lathe or planer.....	1 3/4 in. x 1 in. x 11 1/4 in.	XXXIV. Square nose for axle lathe or planer....	2 in. x 1 in. x 15 in.
XII. Square nose for lathe or planer.....	2 in. x 1 3/4 in. x 15 in.	XXXV. Diamond point for planer.....	2 in. x 1 in. x 14 1/2 in.
XIII. Diamond point for lathe or planer.....	1 3/4 in. x 1 3/4 in. x 15 1/4 in.	XXXVI. " " axle lathe.....	2 in. x 1 in. x 15 in.
XIV. Oyster knife for planer.....	1 3/4 in. x 1 3/4 in. x 15 1/4 in.	XXXVII. Tools for boring cylinders. (Baidwin).	1 3/4 in. x 1 3/4 in. x 5 1/2 in.
XV. Diamond point for planer or lathe.....	1 3/4 in. x 1 3/4 in. x 15 1/4 in.	XL. " " " " ".....	1 3/4 in. x 1 3/4 in. x 3 1/2 in.
XVI. Diamond point for planer, "left hand"...	1 3/4 in. x 3/4 in. x 8 1/2 in.	XLI. " " " " ".....	1 3/4 in. x 1 3/4 in. x 3 1/2 in.
XVII. Diamond point for lathe.....	1 3/4 in. x 5/8 in. x 7 in.	XLII. Square nose for lathe.....	1 3/4 in. x 3/4 in. x 6 1/2 in.
XVIII. Round nose for lathe.....	5/8 in. x 1 in. x 7 in.	XLIII. Boring tools for driving boxes.....	1 3/4 in. x 1 1/4 in. x 6 in.
XX. Boring tool " ".....	1 3/4 in. x 5/8 in. x 8 1/2 in.		
XXI. Left hand side or facing tool for lathe.	1 3/4 in. x 5/8 in. x 8 in.		

Fig. 1—Chilled Cast-Iron Lathe and Planer Tools Used in the Altoona Shops of the Pennsylvania Railroad.

the ashes are raked into the bucket the truck in the pit can be moved so as to bring the bucket within reach of the hoist. The latter consists of a pneumatic cylinder and piston, to which the open bucket in the engraving is suspended. This is carried by a little trolley—shown in the engraving—which runs on the top of the transverse beams. On the left side of the gallows frame, as will be seen, is another vertical pneumatic cylinder, the piston of

which is connected to a wire rope that is carried over pulleys at each end of the horizontal beam, and is attached to the trolley, which can thus be moved transversely to the track. The buckets filled with ashes can thus be hoisted from the pit by the vertical cylinder shown above it, and can be moved laterally by the other cylinder, over the car and opened so as to deliver its contents into the car below. This is all done in less time than it will

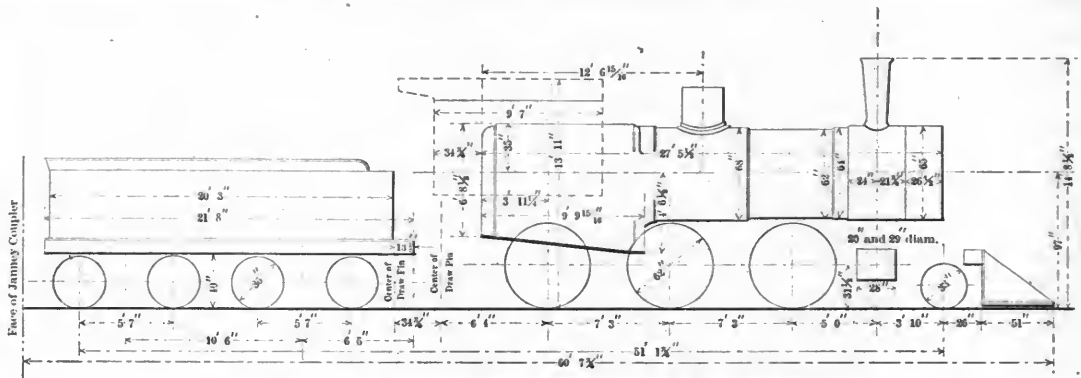


Fig. 3.—Outline of Compound Mogul Locomotives—Pennsylvania Railroad.

take to read this description of it, and saves much work of a very disagreeable kind.

PNEUMATIC SANDING APPARATUS.

The γ -shaped pipe or stand, with a ladder leaning against it, shown on the left side of the engraving, is one of the pneumatic sanding appliances which are used to fill the sand-boxes of locomotives. The sand-house on the right has a sand-dryer of a usual kind. A cylindrical reservoir or tank, $3\frac{1}{4}$ feet in diameter and $5\frac{1}{2}$ feet deep, is placed below the dryer, usually under the floor. This receptacle has a valve on top, through which the sand is fed into the tank. From the bottom of it a pipe communicates with the vertical γ pipe shown in the engraving. The valve on top of the sand reservoir opens inward, so that when compressed air is admitted the valve is closed, but it passes through the sand and into the pipe at the bottom and thence to the γ pipe, and in doing so carries the sand with it. The end of the pipe has a valve and hose which are shown, the hose being intended to conduct the sand to the sand-boxes. A few minutes is all the time required to fill a sand-box, which is done by simply turning on the compressed air when the reservoir contains a sufficient quantity of sand.

COMPOUND LOCOMOTIVES.

A very interesting series of experiments has been in progress on the Pennsylvania Railroad for some time past. It was determined by the managers of the company a year or more ago to make a thorough test of the compound system for locomotives, and to do this four mogul freight engines were built all alike, excepting that a different system of compounding was adopted in each en-

gine. The diagrammatic engraving, Fig. 3, herewith, gives the proportions and principle dimensions of these engines. The systems of compounding which were adopted were the Golsdorf, Van Borries, Pittsburgh and Richmond.

These engines were all completed some months ago, and have since been undergoing a most thorough series of tests in actual service, the results of which cannot help being very interesting to railroad men generally. At the time of our visit to Altoona the tests were not completed, so that no results can at present be given. All that can be said is that a very decided economy in coal consumption by the compound over the simple engines was indicated by the tests so far as they have been made.

We are indebted to Mr. Vogt and Mr. Casanave for a series of diagrams showing the principal features of the various compound systems as they have been applied to the engines referred to.

THE GÖLSDORF SYSTEM.

Fig. 4 represents a transverse section through the cylinders of the engine to which this system of compounding was applied. It will not be necessary to explain to many of our readers that in compound locomotives some special provision must be made to admit steam to the low-pressure cylinder in starting; but in order that those who are not familiar with the compound principle may read this understandingly it may be said that in such engines steam is admitted first to the high-pressure cylinder, and after acting on the piston, it is allowed to escape to a larger or low-pressure cylinder, where it again acts on another piston, and then escapes up the chimney. As the steam is admitted first to the high-pressure cylinder, unless some special provision is made therefor,

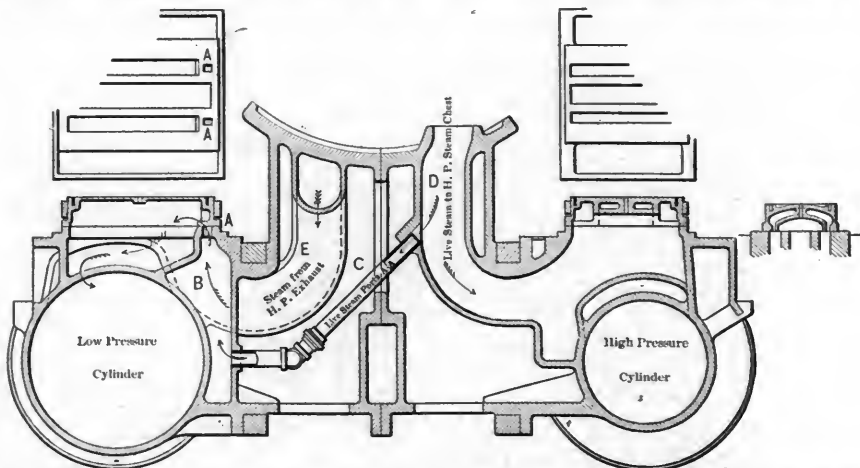


Fig. 4.—Golsdorf System of Compounding as applied to a Mogul Locomotive by the Pennsylvania Railroad.

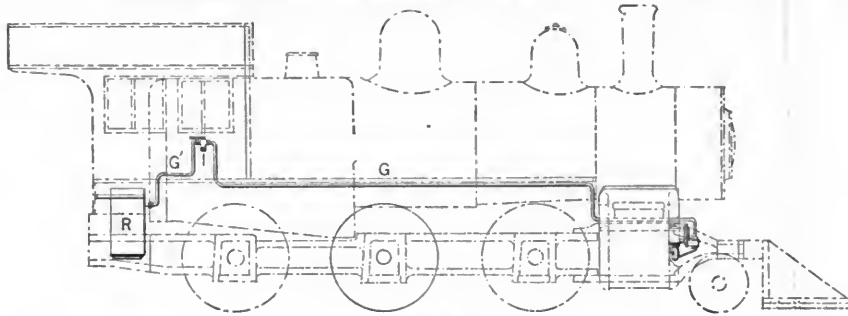


Fig. 5.

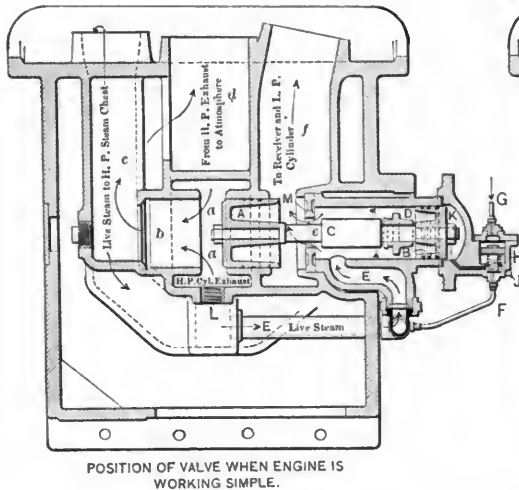


Fig. 6.

The Von Borries System as Applied to a Compound Muel Locomotive by the Pennsylvania Railroad.

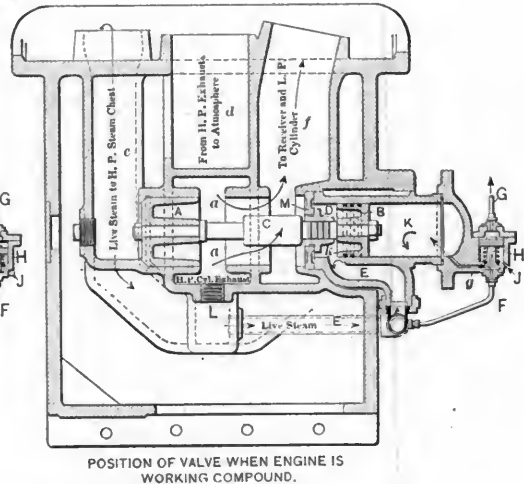


Fig. 7.

no steam would enter the low-pressure cylinder during the first revolution of the wheels, and, as a matter of fact, owing to the cylinders often being cold in starting much of the steam which is then admitted to them is condensed and for a number of revolutions little would flow into the second cylinder. Furthermore, the engine might be standing in such a position that the low pressure piston was at or near the end of its stroke and unable to exert much tractive effort. It is therefore essential in compound locomotives to provide means for admitting steam direct from the boiler to the low-pressure cylinder in starting.

In the Götsdorf system this is accomplished by openings *AA*, which are made in the valve-seat. One of these is shown in the sectional view in Fig. 4, and both of them in the plan view of the valve-seat just above the left-hand cylinder. These openings communicate with a cavity in the cylinder casting, which is connected by a pipe *C* to the steam-pipe *D* of the high-pressure cylinder. In starting when the valves are worked at their full stroke or nearly so their steam edges will uncover the openings *AA*, and by means of the pipe *C* live steam will thus be admitted to the low-pressure steam-chest and cylinder. After the engine is started, and the valves are worked at considerably less than their full stroke, then the parts *AA* are not uncovered and no live steam can enter the low-pressure cylinder, but it is supplied from the exhaust of the high-pressure cylinder which is connected to the pipe *E*.

From the steam-chest of the low-pressure cylinder the live steam passes into the receiver and thence into the high-pressure cylinder, entering on that side of the piston therein which is opposite to that in which the movement of the piston ought to take place.

Thus the steam entering the high-pressure cylinder will exercise a certain counter pressure which, however, will be overcome by live steam from the boiler as soon as the position of the crank undergoes the slightest alteration, such live steam from the boiler entering directly into the high-pressure cylinder.

When the low-pressure slide-valve assumes such a position that the port which until then has been open is closed, the direct admission of steam into the low-pressure cylinder will be discontinued, and, therefore, any injurious counter-pressure that might otherwise result therefrom, is completely obviated, so that the locomotive can then be started by the steam pressure exerted upon the high-pressure piston alone.

THE VON BORRIES SYSTEM.

Professor Woods, in the last edition of his book on "Compound Locomotives," says that "after a number of years' experience with automatic starting gears, that give increased power to compound locomotives; during a part of the first revolution, Mr. von Borries has reached the important conclusion that an independent exhaust with a high-pressure cylinder, such as used by Mallet, is necessary for two-cylinder receiver compounds, with cranks at right angles, when the locomotive has to start heavy trains or work on comparatively heavy grades."

This device has been adopted in one of the Pennsylvania Railroad compounds. In order to enable the engineer to control the exhaust and the working of the two cylinders; that is, to change them so as to work either simple or compound, a three-way cock *I*—shown in the diagrammatic view, Fig. 5—is provided, which is connected by a pipe *G* with the air brake reservoir *R* and by another pipe *G*, with an apparatus on the front end of the cylinder castings shown in Figs. 6 and 7 in sectional views and on a

larger scale. In Fig. 6, the parts are represented in the position they occupy when working simple and in Fig. 7 as they are when working compound; *a a* is a cavity which is connected directly to the exhaust of the high-pressure cylinder. From Fig. 7 it will be seen that when the parts are in the position therein shown that the exhaust steam from the high-pressure cylinder will pass from the passage *a a*, which is connected with the exhaust of the high-pressure cylinder to *f*, and thence to the receiver and low pressure cylinder. The engine then works compound. The parts are held in the position shown by the pressure of steam in the cylinder *K*.

To change the engine to simple working in starting, compressed air is admitted by the three-way cock *I* and pipe *G*, Figs. 5 and 6, to the operating valve *H*. This has a small piston inside, which is connected to a double-seated valve below it. When air is admitted above the piston it is forced down, which closes the opening below the valve and shuts off communication with the pipe *F*. At the same time the valve leaves its top seat, which opens communication through the passage *g*, between the cylinder *K* and the outlet *J*, which is open to the atmosphere. The steam in *K* can thus escape. The opposite end *k* of the cylinder is connected by pipes *EE* with the live-steam pipe. Consequently that end of the cylinder is filled with steam which acts in the piston *B*, which moves it and the parts with which it is connected toward the right or into the position shown in Fig. 7. From this it will be seen that by this movement the piston *A* has been unseated and that communication has been opened from

in the pipe *F*, below the valve, will then raise it and close communication from the cylinder *K* and the atmosphere by the passage *J*, and open a passage from *F* through *g* to *K*, thus admitting live steam to the right side of the piston *B*, which, by reason of the greater effective area on that side, due to the reduction of pressure resulting from the steam flowing to the low-pressure cylinder, will be moved towards the left. This movement first shuts off live steam communication at *e*. Fig. 6, from the pipe *E* to the receiver, and low-pressure cylinder, by means of the reducing plug *C* and then closes communication between the high-pressure exhaust and atmosphere by the seating of the valve *A* and at the same time opening communication between the high-pressure exhaust passage *a a* and the low-pressure cylinder through the receiver passage *f*. The engine is thus entirely under the control of the runner and can be instantly changed from simple to compound working or *vice versa*.

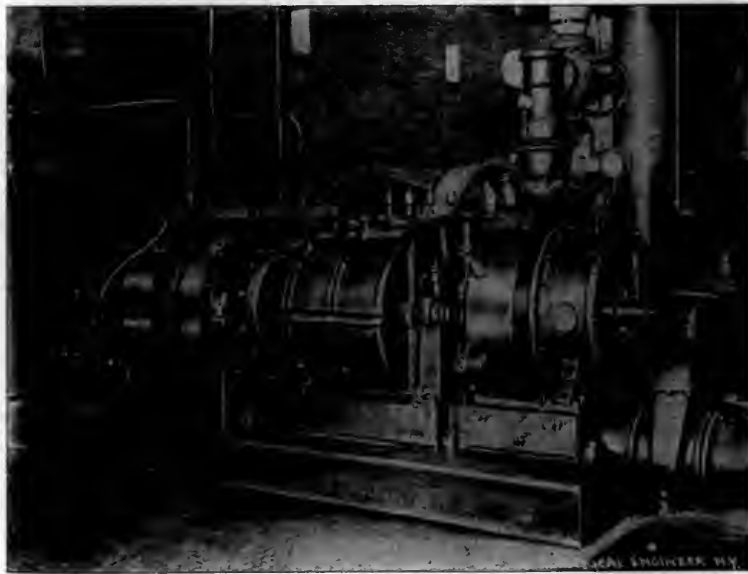
The engravings and explanation have occupied so much space that the description and illustrations of the other two compounds must be reserved for the next article.

Performance of a 300-Horse Power De Laval Steam Turbine in an Electric Lighting Station.

Some time ago the Edison Electric Illuminating Company, of New York, contracted with the Société de Laval, of Paris, for two 300 horse-power De Laval steam turbines. One of these now installed in the Twelfth street station in New York has recently been tested by Messrs. Breguet and Van Vleck, the former representing the builders and the latter the purchasers.

The turbine disc has a diameter of 29½ inches and a thickness through the blades of about ¼ inch, and it runs at 9,000 revolutions per minute. The motion is transmitted by gearing to two Desroziere dynamos running at 750 revolutions. The entire equipment of one turbine, its gearing and two dynamos occupy a floor space of 13 feet 3 inches by 6 feet 5½ inches, and a height of only 4 feet 3 inches. When operating condensing with a steam pressure of 14½ pounds above the atmosphere and a vacuum of 26 inches, the steam consumption was guaranteed to be not more than 18.7 pounds per brake horsepower under full load.

In the accompanying illustration is shown the apparatus tested. The steam is supplied to the turbine through the large valve on top of it and the jets are turned on and off by the small valves around the periphery of the casing, three of them being in sight in the photograph. The exhaust passes out through the large valve below and to the right of the turbine. The gears are



300-Horse Power De Laval Turbine at Twelfth Street Edison Station, New York.

the cavity *a a*, which communicates with the exhaust of the high-pressure cylinder to *d*, which latter leads to the atmosphere.

When the parts are in the position shown the exhaust steam from the high-pressure cylinder can therefore escape directly through the passage *b* to *d*, as indicated by the arrows, and thence to the open air. This cylinder is then working simple. At the same time live steam can flow through the pipes *E, E*, passage *e*, into *f*, which is connected with the reservoir and low-pressure cylinder. Under these conditions both cylinders will work simple. It should be explained that the parts shown in the engraving, that is the pistons *A* and *B*, and plug *C*, are kept in the position in which they are represented by the pressure of the live steam on the left side of the piston *B*.

To work the engine compound the air pressure in the operating valve *H* is released by the three-way cock. The steam pressure

in the casing to the left of the turbine and there is a second dynamo directly back of the one in the foreground.

The tests were each of six hours' duration and all readings were taken by two observers. The result of the full load test is as follows:

Average of readings:			
127.23 volts.	692.48 amps.	128.26 volts.	709.18 amps.
127.23 × 692.48 =	88,118.080 watts +	side	
128.26 × 709.18 =	90,949.427	—	
Avg. watts.... 179,077.507 " both sides			
179,077.507 is 90 per cent. of 198,975.91 watts = 226.72 h. p. × 6 = 1,600.32 h. p. hours.			
Weight of water discharged from air pump, 6 hrs. = 27,763 lbs.			
H. P. hours developed..... 6 hrs. = 1,600.32			
Lbs. of water per B. H. P. hour..... 17,318 lbs.			
Lbs. of water per E. H. P. hour..... 19,275 lbs.			

The result of tests with varying loads is given below, the num-

ber of jets in use varying from two to seven in the different tests:

No. of jets used.	Average load— + Amps. — Amps.		Average watts— + —		Per cent. of full load.	Vacuum.	Pounds of steam per E. H. P.
2	153.78	147.15	18,707	19,283	18.50	27	27.55
3	133.60	145.80	54,156	57,886	56.02	26.43	20.22
6	700.85	718.65	87,746	91,268	89.51	26.07	19.75
7	771.94	787.33	97,418	106,856	99.14	25.79	19.95

In making these tests the power readings were obtained from the delivery of the dynamos, and the electrical horse-powers given above and the steam consumptions per electric horse-power are therefore the result of direct observation. The brake horse-power is calculated by assuming that the dynamos have an efficiency of 90 per cent.

We understand that these are the first Laval steam turbines of such large power to be put into commercial use in this country.

Communications.

A Novel Method of Obtaining Dynamometer Cards.

PHILADELPHIA, Aug. 25, 1896.

EDITOR AMERICAN ENGINEER, CAR BUILDER AND RAILROAD JOURNAL:

At a recent engine test near Stroudsburg, Pa., conducted by Edwin E. Boyer, M. E., of Philadelphia, a novel instrument to obtain a card from the dynamometer was presented, and caused some little comment.

The dynamometer was the ordinary prony brake, but in place of the customary platform scales, at the end of the arm was placed a spring made from $\frac{1}{2}$ -inch steel, wound on a 2-inch core, and designed from Begtrup's formula, to be of such a length as to give a deflection of 3 inches under its maximum load of 2,500 pounds.

This spring was placed in a hollow cylinder which carried a scale graduated for every hundred pounds. On the index of the spring was fastened a pencil which pressed against the card carried by an aluminum cylinder about 3.8 inches in diameter and $3\frac{1}{4}$ inches high.

This cylinder was operated by clockwork to revolve once an hour, and was so adjusted that the maximum movement of the index (3 inches) was produced on the card.

The ordinate on the card was divided in 25 spaces, each space therefore representing 100 pounds pull, and the abscissa was divided into 120 spaces, each space representing an interval of 30 seconds.

The duration of the test was 8 hours, and indicator cards were taken from each end of the cylinder every 10 minutes.

The necessity of a dynamometer card was caused by the great vibration of the arm of the brake, these vibrations being too great to obtain accurate results with platform scales.

The test was in every respect a success, and reflects much credit on the young engineer in charge. R. M. WILSON.

Tests of Car Wheels.

EDITOR AMERICAN ENGINEER, CAR BUILDER AND RAILROAD JOURNAL:

We have noted with interest the correspondence in your September issue concerning the special tests made on cast-iron wheels by casting a ring of molten iron around the rim of the wheels.

The company with which the writer is connected has made a great many experiments in this direction which are interesting in a sense, but they are entirely useless so far as showing any actual conditions which arise in service.

It would be as possible to prove that a gun was not of proper strength or construction by putting in a charge several times greater than ever would be used in actual service and exploding it. Car wheels are never instantly heated by brake service, but they become gradually, and often rapidly, hot from the friction of the brakes and on long grades the heat becomes severe, but even then nothing to approximate the heat of a body of molten metal as is mentioned in your paper. As a matter of fact the conditions are almost exactly reversed from those of actual service, for in service the brake is applied cold and friction gradually heats the wheel, while in this "test" a great extreme of heat in the shape of molten metal is applied instantly and allowed to gradually cool.

The modern foundry makes car wheels to meet the requirements of the service to which they will be subjected, the same as bridge

builders have their beams and trusses of the requisite strength and electricians make their motors of the necessary power, etc.

We might as well claim that by overloading and breaking an engine that all engines of that grade and strength are faulty and dangerous as to assume that wheels subjected to a series of satisfactory tests approximating the actual requirements of service are not safe because one wheel cannot resist the strain of molten metal applied to its rim in a mass 4 inches deep and $1\frac{1}{2}$ inches wide—an amount of heat and strain that would not be applied to the wheel in actual service were it to run a hundred years. C. V. S.

A New Railroad Club.

A railroad club is being organized in Denver whose membership will be made up chiefly of persons connected with the mechanical departments of the railroads in that vicinity. As managers and superintendents already have an organization there, the new club will do well if it will put itself in close touch with those officials, as co-operation between the officers of various departments can be thereby promoted.

Subjects to be Reported Upon at the 1897 Conventions.

Besides the standing committees on Arbitration, Supervision of Standards, Triple Valve Tests, Standard Wheel and Track Gages, and Brake Shoe Tests, the Master Car Builders' Association has appointed committees to report on: 1. Automatic Couplers. (To advise what changes may be desirable in the standard size of Master Car Builders' automatic coupler shank, and to recommend a standard yoke or pocket strap for rear attachment to car.) 2. Uncoupling Arrangements for Master Car Builders' Automatic Couplers. (To consider whether a standard uncoupling device is practicable, and the details thereof, and to recommend a device which would be applicable to the greatest number of couplers possible.) 3. Loading Logs, Poles, Bark and Long Structural Material on Cars. 4. Trains Parting. (To consider the extent and causes of break-in-tows with automatic couplers, and to suggest remedies.) 5. Passenger Car Pedestal and Journal Box for Journal, 4½ inches by 8 inches. (To suggest designs.) 6. Specifications and Guarantee for Cast-iron Wheels. (To propose a revision of the recommended practice and to consider therewith the form of wheel.) 7. Air-Brake and Signal Instructions. (To confer with a committee from the Master Mechanics' Association and propose a revision of the code adopted in 1892.) 8. Freight Car Buffers. (To report upon experiments about to be made with improved buffers.) 9. Box-Car Side and End Doors. (To submit designs for adoption.) 10. Arch Bars and Column Bolts for Diamond Trucks. (To recommend forms in detail, for cars of 60,000-pounds capacity, and to submit designs for same for cars of 80,000-pounds capacity.) 11. Five individual reports on Designs for Steel Car Frames.

The subjects for the Master Mechanics' convention are as follows: 1. Exhaust Nozzles and Steam Passages. (Discussion of the report for 1896 is made the first order of business for 1897. Members are requested to co-operate with the committee by experimenting upon its conclusions and reporting to it.) 2. Counterbalancing Locomotives. (To designate a number of roads to confirm or disprove the recommendations in the report of 1896.) 3. Truck Swing Hangers. (The proper angle for swing beam hangers in locomotive trucks.) 4. Locomotive Grates. (For burning anthracite coal.) 5. The Apprentice Boy. (To recommend a course of shop training for apprentices, and to make recommendations in regard to their technical education.) 6. Best Metal for Cylinders, Valves and Valve Seats. 7. Boiler Jackets. (Which is the most economical, a boiler-jacket of planished iron or of common sheet-iron or sheet steel, painted?) 8. Ratios of Grate Area, Heating Area and Cylinder Volume. 9. Piecework in Locomotive Repair Shops. 10. Motors: Steam, Air and Electricity. (In a locomotive repair shop what class of work can best be performed by air motors, and what is the relative convenience and economy of air motors, electric motors and steam motors for such work?) 11. Revision of Air-Brake and Signal Instructions.

A Few Facts and Opinions on the Design of Express Locomotives.

The official report of the discussion on express locomotives at the 1895 London meeting of the International Congress has recently been published, and from it we have gleaned the following remarks by various speakers, some of which are interesting because of the information conveyed, while others serve to show the lack of information on the details of American practice existing in Europe.

Mr. Aspinall, in speaking of crank axles, said: "I am very often asked by American engineers, how long these crank axles last? I have not given any figure in the paper, and I would mention that a great many erroneous views seem to exist on this point. It so happens that in this country we have to make returns to our Board of Trade of all axles which break in service, and not the axles which are taken out in the workshops by reason of a flaw. The result is, that a certain number of figures exist at the Board of Trade which show that a certain number of axles have broken after, perhaps, having run a comparatively short time, and those figures are published. As a consequence, people often infer that the life of a crank axle is very short. This is quite a mistake. It is shorter than people would like, no doubt, but we have many axles running 400,000 miles. I have had a number which have run up to 600,000 miles, which were taken out when the engines were rebuilt, and, had it not been that they were of an old pattern, would have been good for further service. It is, I think, desirable to lay stress upon this point, because our Board of Trade, and others who write in some of the technical journals, have an idea that when axles have run, say 200,000 miles, they ought to be taken out and condemned."

In discussing counterbalancing, Mr. Webb, of the London & Northwestern, was asked for his rule for determining the weight of the balances, and replied as follows: "In the case of non-compound engines we put weights in the driving wheels equal to half the weight of the reciprocating parts, plus the whole of the weight of the revolving parts. In our compound engines, for the high-pressure wheels, we use the same rule as above, but in the low-pressure wheels we put weights equal to the whole of the revolving and reciprocating parts combined, and we find that this practice gives very satisfactory results in the steadiness of the engine. The weights so obtained are not excessive."

On the subject of the use of leading trucks, Mr. Worsdell, of the Northeastern Railway, gave the practice of his road as follows: "We use the bogie principle entirely for our express engines now, because I found out in actual practice that it gives the drivers very much greater confidence in running if they have a four-wheeled truck in front. Unfortunately, the North Eastern Railway has a number of curves, and most of our main-line stations are on curves, and it is a very difficult matter to start away from these stations, especially at Newcastle, where we have a reverse curve to contend with, and I am very strongly in favor of the bogie principle for express engines. The express engines on the North Eastern Railway run at very high rates of speed with some of the trains, and whereas I found that with the same class of train with an express train having a single pair of wheels in front our men were in the habit of losing time, I also found out from the men themselves that they did not like to run at a high rate of speed owing to having a single pair of wheels only in front."

On the same subject, Mr. Baudry, of the Paris-Lyons-Mediterranean Railway, said: "Formerly our express locomotives used to have no leading bogie, but we cannot well compare them with our present engines because the patterns are by no means similar. In our new engines the weight is more concentrated toward the middle, and on the other hand their wheel base is longer. They are also much easier on the road, but this improvement cannot be attributed to the use of a bogie. In order to test the effect of a bogie, the two first locomotives of this pattern were built one with a bogie and the other with a simple carrying axle, but otherwise exactly similar. I must confess that the engine without a bogie was at least as easy upon the road as the one with a bogie, besides being a little lighter and simpler in construction. Nevertheless,

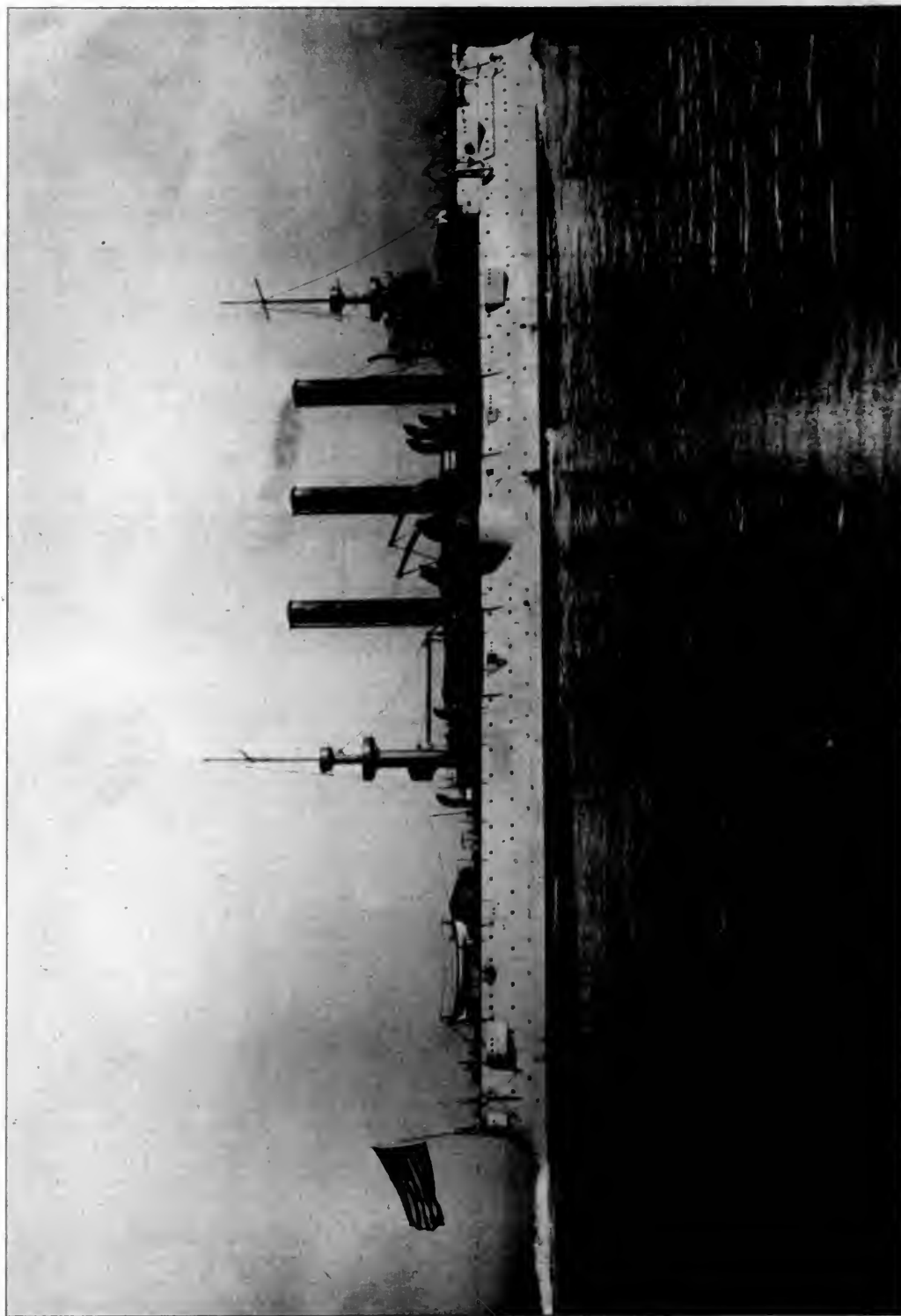
I myself declared in favor of the bogie and my company is of the same way of thinking. Indeed, it seems indubitable that the bogie is safer.

In reply to a question about balanced valves, Mr. Worsdell said: "I do not think we have had sufficient experience upon our North Eastern line to give you any valuable information at present upon the subject of the balanced slide valve. We are experimenting with balanced valves, and I am now building 10 engines and putting on the piston valve to engines, but that has been done so very recently and the engines have been working for so few months that we would rather not say anything about them on this occasion. I might just mention with regard to the piston valve that although we have only had some six months' experience in the working of these engines, yet I have put these five engines working in express trains against 10 engines of a similar class and the consumption of fuel in the last six months has effected something like 10 per cent. saving; but whether that will be carried out in the whole 12 months' running is yet to be seen."

At the close of the discussion on slide valves the President made a remark that will read strangely to our readers in view of the widespread use of balanced valves here. He said: "I think we all agree that if a simple and practical method can be found of applying balanced slide valves we shall not refuse to try them on our engines. All that is required is to find a simple and cheap method which will not complicate the machinery, and not be extravagant to maintain."

Mr. Ely, of the Pennsylvania Railroad, being called upon, made this statement of the practice on his road: "It is our practice to build our express locomotives with bogies. Usually these locomotives have two pairs of drivers and a four-wheeled bogie, making eight wheels in all. On the portions of our lines where the passenger trains are not frequent and the trains are very heavy, we use, to some extent, locomotives with three pairs of drivers, making what we term a ten-wheeled locomotive. But we do not approve of this practice for general express service. We believe that the work to be done, taken in connection with the allowable weight upon each pair of drivers, should suggest the design. For light trains locomotives with a single pair of drivers should be prepared if the weight on the drivers is not excessive; we have no such locomotives. For heavier trains two pairs of drivers; for still heavier, three pairs should be used, and so on, always keeping the weight on each pair within the prescribed limits. We think that every pair of drivers adds complications of machinery and friction. For a number of years, especially since pressures up to 200 pounds have been in vogue (on some locomotives we carry 210 pounds pressure), we have felt that the Belpaire principle secures to us perfectly safe and reliable boilers. It is a straightforward construction; all the bolts, etc., are at right angles; and while with it as large a heating surface cannot as well be obtained as by some other forms, we have found them on the whole very satisfactory. As to the question of speed, very little can be said that is new. Unfortunately the builders of locomotives thirty or forty years ago did not have track upon which they could safely speed them—else, I am afraid, our present records would not seem so remarkable. I believe that the locomotive of 30 years ago would probably travel as fast as the locomotive of 1895, so far as the principle of construction is concerned. It is possible for any railroad that has a sufficiently good roadbed to make almost any speed that is desired; but there is an economical limit which should not be exceeded."

The President asked Mr. Ely if he would tell them about certain express trains of which he had been speaking in private shortly before, and Mr. Ely in reply said: "We have a class of trains in America that are called 'newspaper trains.' They are leased or hired by the great metropolitan dailies to carry the early morning papers to seaside resorts, and the train which I spoke to you about made a run of 58½ miles in 45½ minutes. That was without any special preparation. I mean to say the locomotive was one of those used in regular service on these trains. The average speed is between 76 and 77 miles an hour for the whole distance."



Copyrighted 1896, by Wm. H. Raw, Philadelphia.

The United States Armored Cruiser "Brooklyn" as it Appeared on its Official Trial Trip, August 27, 1886.—Speed, 21 9117 Knots per Hour.
Built by the Wm. Cramp & Sons Engine and Ship Building Co. of Philadelphia, Pa

The United States Armored Cruiser "Brooklyn."

On Aug. 27, the United States armored cruiser *Brooklyn* underwent a very successful trial trip off the Massachusetts coast, developing an average speed of 21.9117 knots per hour over the entire course of 83 miles and reaching a maximum of 22.90 knots, which was maintained for some miles. By this performance the vessel takes a position at the head of her class among the navies of the world, and also earns a premium of \$350,000 for her builders, the Wm. Cramps & Sons' Ship and Engine Company, of Philadelphia. It is to be noted that during the trial trip the machinery worked so well that no heating or cutting of bearings took place.

In the full-page engraving accompanying this article we give a view of the vessel taken during the trial trip, and in Fig. 2 we show two half cross-sections through the engine rooms. The length of the cruiser on the load water line is 400.5 feet, the extreme beam 64.68 feet, mean normal draft 24 feet, normal displacement 9,271 tons, displacement on trial 8,150 tons. The indicated horse-power of the engines is placed at 16,000, the normal coal capacity 900 tons and the total coal capacity 1,753 tons. The contract called for a speed of at least 20 knots with a premium of \$50,000 for each one-quarter knot in excess of that figure.

The boat is propelled by two screws, each driven by two triple-expansion engines, making four engines in all, each placed in a separate water-tight compartment. The object of this division of the propelling power into four units, is to provide for a reduced engine power for ordinary cruising with more economy than is possible when running large engines at half power. For such cruising the forward engines will be disconnected at shaft couplings provided for the purpose, and the two after-engines will turn the screws. They will then work with practically full power and consequently with economy. Each engine has a high-pressure cylinder 32 inches in diameter, one intermediate 47 inches and one low-pressure cylinder 72 inches in diameter. The stroke of all pistons is 42 inches.

The engines were calculated to make 129 revolutions per minute when generating 16,000 horse-power. The engines are placed in the boat with the high-pressure cylinders forward. The main valves are all of the piston type, there being one for the high-pressure, two for the intermediate, and two for the low-pressure cylinder. The intermediate and low-pressure cylinders are steam-jacketed. The engine frames are of cast steel and of the inverted Y form. The bed plates are also of cast steel and are supported

on wrought-steel keelson plates. The crank shafts are each in three sections. All shafting is hollow. The after-section of each propeller shaft is of nickel steel, 17 inches in diameter, with a 11-inch hole through it, except at the propeller fit, where the thickness of metal is nowhere less than 4 inches. The thrust shafts are of mild steel, 16½ inches diameter, with a 7¼-inch hole through them. There is one condenser for each engine, with a cooling surface of about 5,681 square feet. The main circulating pumps are of the centrifugal type, one for each condenser. The air pumps are independent, double-acting, horizontal, two for each engine. In each after engine room there is an auxiliary condenser of sufficient capacity for one-half of the auxiliary machinery.

The steam is supplied by five double-ended main boilers and two single-ended boilers (used either as main or auxiliary boilers) of the horizontal-return fire-tube type. They are 16 feet 3 inches outside diameter and four of the double-ended boilers are 18 feet long, the fifth 19 feet 11½ inches long, while the two single-ended boilers are each 9 feet 4½ inches long. The boiler pressure carried is 160 pounds. The boilers are arranged in three water-tight compartments. The total grate area is 1,016 square feet, and the total heating surface 33,353 square feet.

The forced draft is on the closed stokehold system, and the air is furnished by two Sturtevant blowers for each fireroom. Blake pumps are used for nearly all water-pumping purposes throughout the ship except at the evaporators, where Davidson pumps are installed.

The hull of the vessel is of steel, not sheathed, with a double bottom and close water-tight subdivision, carried up to about 12 feet above the water line. The arrangement of decks above water provides an unusual freeboard and berthing accommodations. It will be noticed from the full-page engraving that there is one more deck forward than aft. There are two military masts with fighting tops. The boats are stowed clear of the blast of the guns, but two life boats are so carried that they may be readily lowered under all conditions of weather.

The hull is protected by means of a steel protective deck worked from stem to stern and supported by heavy beams. The edges of this deck, amidships, are 5 feet 6 inches below the 24-foot waterline, the top of the deck rising to this water line at the center of the vessel. On the slopes over the machinery and boilers the deck is 6 inches thick; on the horizontal portions it is 3 inches thick; forward and abaft the machinery and boilers, to stem and to stern, the deck is at the thinnest part not less than 2½ inches

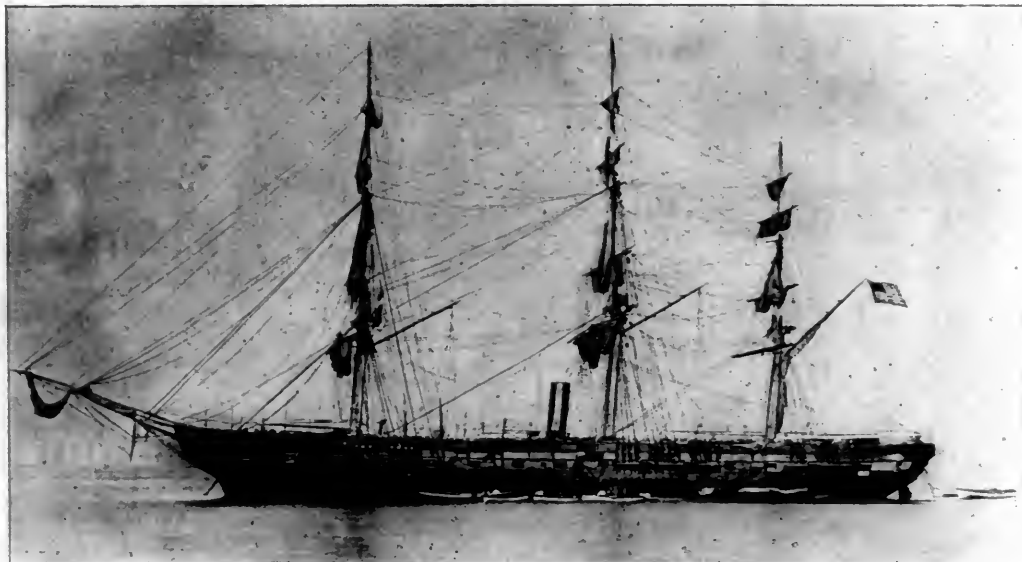


Fig. 3.—U. S. Sloop-of-War Brooklyn—Built 1858.

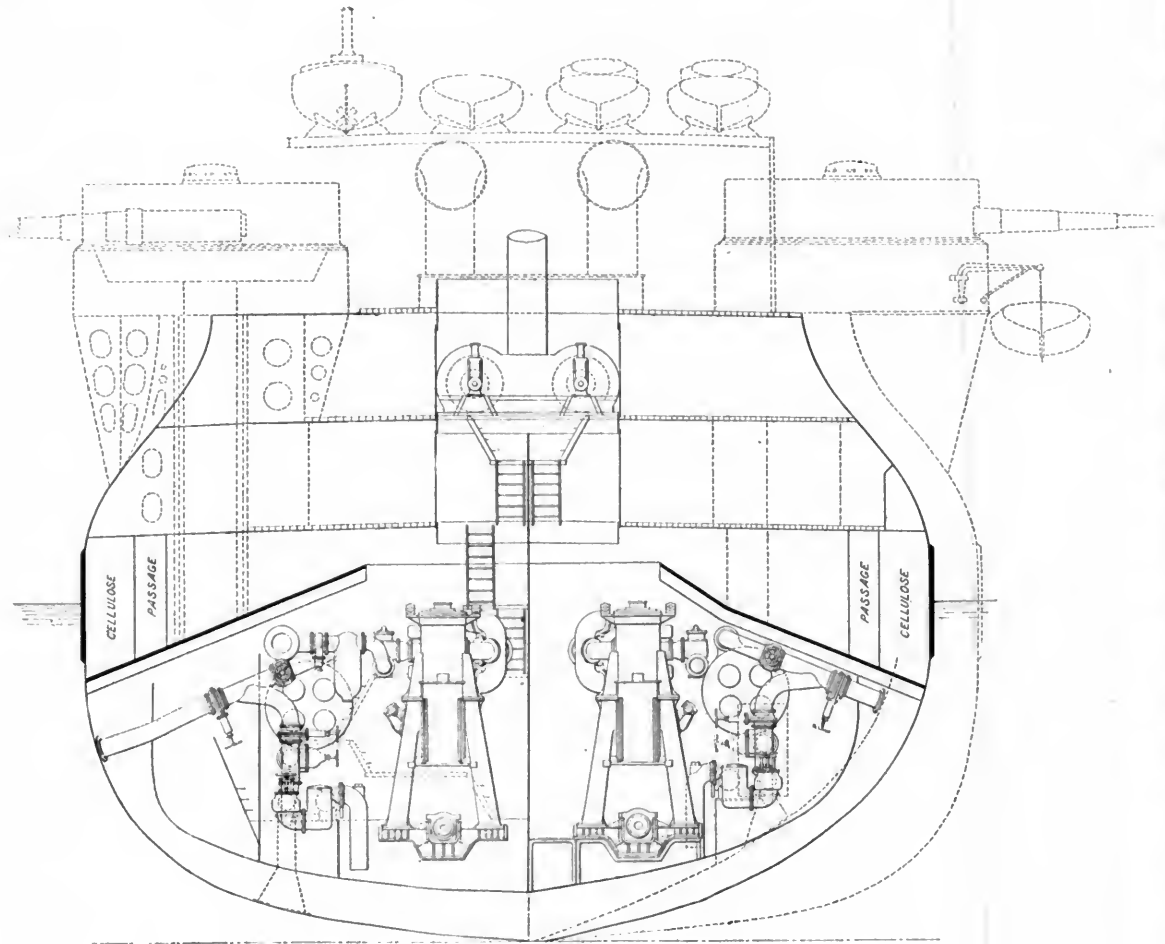


Fig. 2.—Sections of the United States Armored Cruiser Brooklyn.

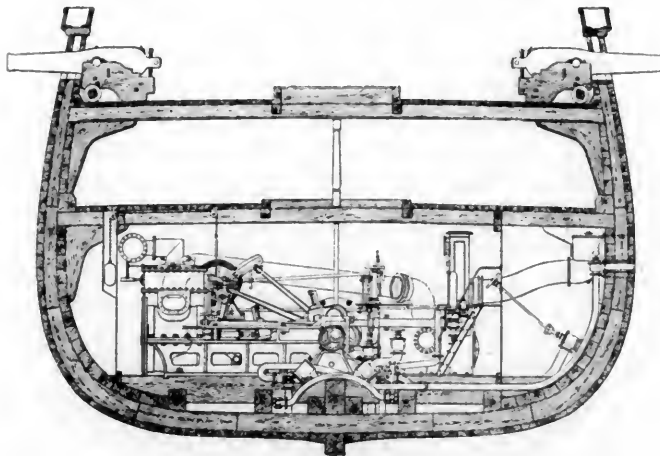


Fig. 4.—Section of the U. S. Sloop-of-War Brooklyn, Built in 1858.

in thickness. Below this deck are placed the propelling machinery, steering gear, magazines, shell rooms, and all that is ordinarily styled "the vitals of a warship."

Protection of the hull from injury to the water-line region is afforded by means of an armor belt 3 inches in thickness, extending the length of the machinery and boiler space, and in depth from 4 feet above the 24-foot water-line to 4 feet 3 inches below it. On the inside of this armor belt and skin plating is a backing of cellulose $3\frac{1}{2}$ feet thick, extending the whole length of the vessel and from the armor deck to the berth deck.

Coal is carried above the armor deck for a length corresponding to the inner bottom, this space between the armor deck and the deck above being subdivided by water-tight bulkheads into 38 coal-bunkers, exclusive of cofferdam and passages. The space forward and abaft these bunkers is subdivided for stores.

A conning-tower 8 inches in thickness stands in a commanding position, having a tube to the protective deck 5 inches in thickness for the protection of speaking-tubes, bell wires, etc.

The battery of the vessel comprises eight 8-inch B. L. R. of 35 calibers, twelve 5-inch B. L. R. rapid-fire guns, twelve 6-pounder rapid-fire guns, four 1-pounder rapid-fire guns, and four machine guns. The 8-inch guns are mounted in four barbettes turrets, placed one forward and one aft on the center line of vessel, and one on either side amidships. The guns in the turrets on the center line of the ship have a train of 310 degrees; those in the side turrets fire from right ahead to right astern or train through an arc of 180 degrees each, and it was partly to obtain this desirable feature that the sides of the hull were given the "tumble home" so noticeable in Fig. 2. Thus six 8-inch guns can be trained simultaneously in any desired direction. The centers of the side turrets are distant from the center line of the vessel about 23 feet. The armor forming the barbets, which will protect the carriages, platforms and turret machinery are 8 inches in thickness for a portion at least equivalent to the train of the guns of the respective turrets, the remaining portions being reduced to 4 inches in thickness. Under the turrets there will be placed 3-inch armor supporting tubes which will also protect the ammunition hoist. The armor of the turrets is $5\frac{1}{2}$ inches in thickness.

The 5-inch guns are protected by fixed segmental shields 5 inches in thickness. The crews of these guns are further protected from explosive shells by splinter bulkheads $1\frac{1}{2}$ inches in thickness. Protection is afforded the smaller guns by shields and extra side plating.

The forward and starboard turrets of the ship are operated by electricity, and the port and aft turrets by steam. As this is the first time that electricity has been used for this purpose in the United States Navy, the operation of the electric machinery for the turrets will be watched with interest.

The torpedo outfit consists of five torpedo tubes, one in the bow and two on each side, six Whitehead torpedoes and a suitable allowance of gun-cotton for mines and miscellaneous purposes.

Distilling apparatus and evaporators supply fresh water, the capacity of the evaporating plant being 10,000 gallons per day. A one-ton Allen ice machine is also installed on the boat.

The electric current for lighting is supplied by three dynamos, and a fourth supplies the current for operating the turrets. The steam steering gear is novel in that it is electrically controlled, that is, the connections to the steam steering engines from the conning-tower are electrical, not mechanical.

The ship will have a radius of action at full speed of 1,758 knots, and a radius of action at 10 knots of 6,088 knots. The complement of officers and men will be 561 persons.

The many steps in the advancement of marine engineering and naval construction have followed each other so closely in the last few decades that few of us stop to think of how much has been accomplished in a short time. To illustrate the rapidity of this progress we have reproduced, in Figs. 3 and 4, a photograph and cross-section of the old United States sloop-of-war *Brooklyn*, these engravings being on the same scale as those of the new *Brooklyn*. In Fig. 2 the engines are shown as they appear looking aft, but we have added in dotted lines the amidship turrets, guns, etc., also the amidship section to make possible a comparison with Fig.

4. A correct idea is therefore obtained as to the relative size of the two boats, and their cross-sections also give a somewhat imperfect idea of the difference in the magnitude of the propelling machinery. In comparing the two cross-sections the reader has to bear in mind that there are twice as many engines on the new *Brooklyn*, as seen in Fig. 2; there are also seven boilers on the new, as against three on the old, to say nothing of electric-lighting plants, refrigerating and evaporating machinery, turret-turning engines, hydraulic machinery, steam steering apparatus, etc., etc., none of which were to be found on board men-of-war built 40 years ago.

The old *Brooklyn* was built in 1858, and cost \$417,921. It had auxiliary steam power in the shape of a double horizontal engine driving a single screw. The steam cylinders were 61 inches in diameter and 33 inches stroke. The principal dimensions were as follows: Length between perpendiculars, 233 feet 4 inches; breadth, 43 feet; mean draft, 19 feet 6 inches; displacement, 3,000 tons; indicated horse-power, 1,116; speed, 10 knots; coal capacity, 300 tons. Complement: Officers, 23; men, 268; total, 291. After a most creditable career the boat was sold in 1891 for \$13,128.

A brief study of the two sets of engravings accompanying this article will not only impress upon any thoughtful person the great changes introduced in less than 40 years into naval warfare by modern guns and armor and by the use of steam for the propelling power, but ought to convince every reader in an equally impressive manner of the reliance which must be placed upon the engineer officers in designing, building and operating these modern vessels. The engineer, though at present not accorded his proper status in official circles, is the leading spirit in all this work. Without him such marvelous vessels could not be built, and if built could not be operated for a single day.

We are indebted to Commodore Melville, Chief of the Bureau of Steam Engineering, U. S. N.; Commodore Hichborn, Chief of the Bureau of Construction, U. S. N., and Mr. W. H. Ross, of Philadelphia, for the drawings and photographs from which our engravings were made.

CONSTRUCTION AND MAINTENANCE OF RAILWAY CAR EQUIPMENT.

BY OSKAR ANTZ.

(Continued from page 217.)

FREIGHT TRUCKS—(CONTINUED).

To relieve the body of the car from shocks due to running over rough places in the track, springs are introduced between the spring-plank and the truck bolster. Steel springs, both of the coil and the elliptic pattern, are used for this purpose; the use of the latter is, however, almost entirely confined to live stock and other cars on which it is desired to obtain a more than usually easy motion. The bolster springs are placed as nearly as possible on the line of the archbars, so as to relieve the spring-plank of undue strains, and they are kept in place by being set in pockets which in their turn are fastened to either spring-plank or truck-bolster, or merely rest on the former, dowels or lugs being provided to prevent their displacement.

Spiral springs are usually arranged in groups, varying in number from three to six, or even more springs to each group, four being the usual number for modern cars. The springs are of such capacity that they are slightly compressed with the weight of the car body empty, and the total capacity is somewhat in excess over the pressure that can be brought to bear on each spring when the car is fully loaded. Single coil springs are generally used for each member of the group and the diameter of the steel from which they are made varies from $\frac{3}{4}$ to $1\frac{1}{2}$ inches, 1 inch being the usual size. Springs made from steel, the section of which is not a circle, are used somewhat, but very little on recently built cars. The diameter of the bolster springs usually runs from 5 to 6 inches and their length from 6 to 7 inches, where four spring are used to each group.

With the modern large cars, the load which can be carried is about twice the weight of the car or over three times the weight of the body alone, and the compression of the springs is there-

fore considerable when the car is loaded, if the spring is light enough to give an easy motion when the car is empty.

To obtain a spring which has a minimum resistance under a light weight and a much larger one under a heavy load, two coils can be used for each member of the group, the inner coil being made shorter than the outer one, so that it will not be under any strain until the outer coil has been compressed a certain amount,

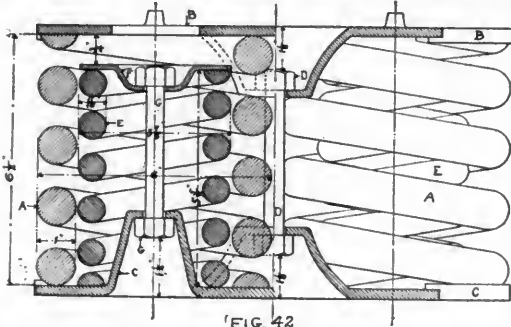


FIG. 42

say slightly over the compression due to the weight of the car body alone.

Such a spring is shown in Fig. 42, where *A A* are the outer

coils, 6 inches in diameter and 6 inches long, made of 1-inch diameter steel wire; there are 4 springs to a group, which are held in place by the two malleable iron or pressed steel plates, *B* and *C*, which are fastened together by the bolts and nuts, *D D*. The inner coils, *E E*, are $3\frac{1}{2}$ inches in diameter and $5\frac{1}{2}$ inches long, made of $1\frac{1}{4}$ -inch steel, and held between the lower spring plate, *C*, and cap, *F*, by means of the bolt, *G*. As will be seen, this spring will be compressed against the resistance of the outer coil alone until the cap *F* strikes the upper spring-plate *B*, when the inner coil comes into action, as well as the outer one, increasing the resistance of the spring about double. In designing a spring like this, care must be taken that the bolts *D* and *G* are short enough so that they will not interfere with the spring being compressed to its full capacity.

TRUCK BOLSTERS.

Until very recently, wood was almost the only material used for truck bolsters of freight cars, but with the extensive introduction of iron in car construction, it has almost superseded wood for this purpose, at least on a number of large roads. Iron was first introduced into truck bolsters in the shape of plates inserted into the bolster, or bolted between the several parts into which it was cut, forming the so-called sandwiched or composite bolster, one great objection to which is that the wood shrinks and leaves the bolts loose, thereby making the bolster weaker perhaps than one of all wood. More recently arches of

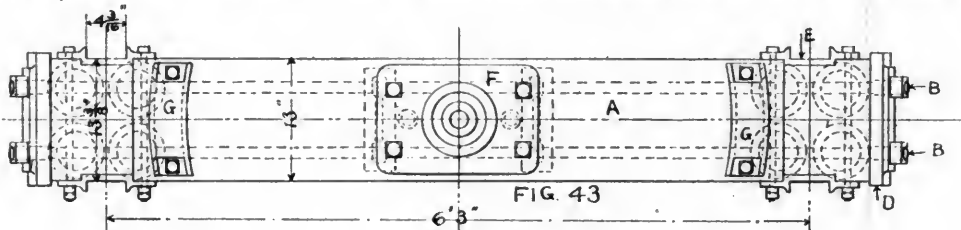


FIG. 43

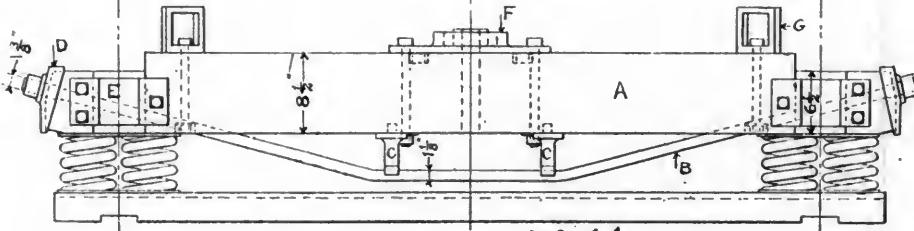


FIG. 44

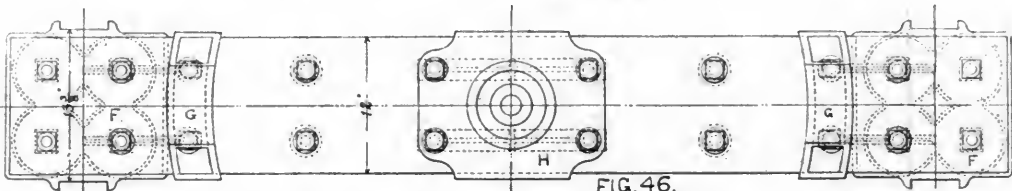


FIG. 46.

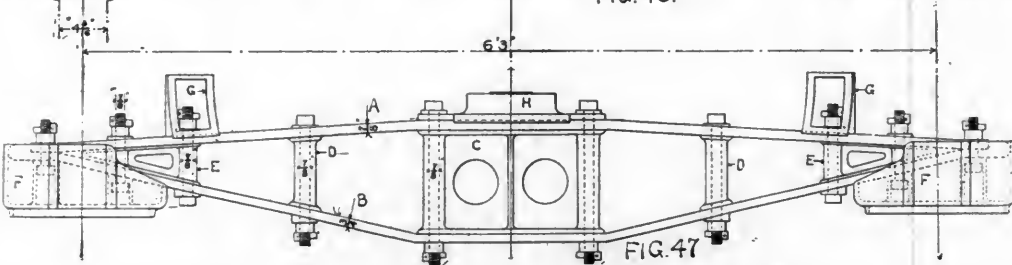
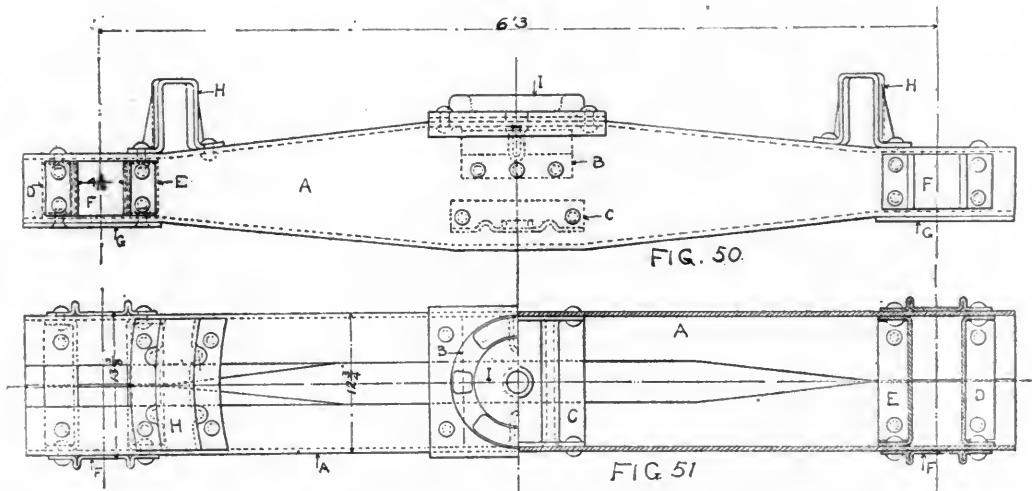
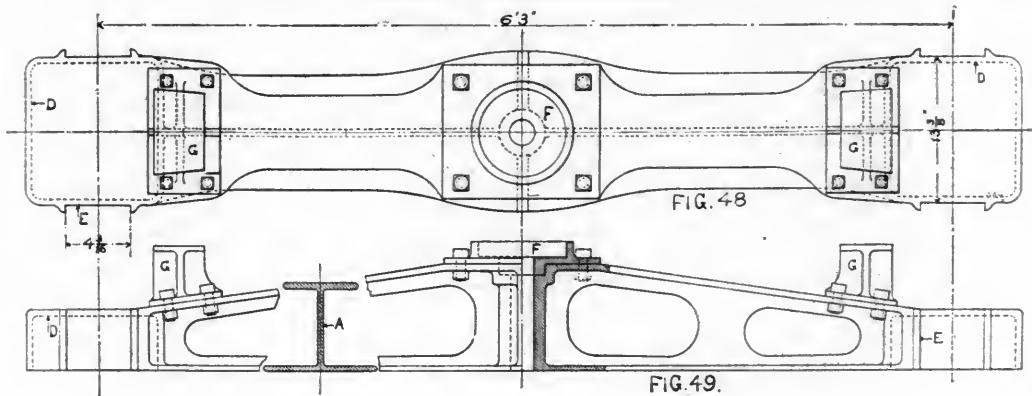


FIG. 47



flat bars, steel castings and pressed steel have been used respectively for truck bolsters; and these will be described individually.

There is more or less diversity in the details of wooden truck bolsters, the cross section being the same on hardly any two roads, some using one solid piece of wood, some two pieces bolted together, and others again introducing flat plates, channel bars or I-beams, those without any iron stiffeners being trussed by rods, Figs. 43, 44 and 45 show a good form of the latter, which will fit the truck frame illustrated in the last issue. The bolster *AA* is made of oak, $8\frac{1}{2}$ by 13 inches in section, and is cut down to $6\frac{1}{2}$ inches deep at the ends, where it projects through between the arch bars and column guides. It is trussed by means of truss-rods *BB*, $1\frac{1}{4}$ inches in diameter, with the ends enlarged to $1\frac{1}{2}$ inches. The rods are bent to shape and then inserted in place through slots cut in the bottom of the bolster, which are filled up by pieces of wood, after the rods are in place. On the lower side of the bolster the rods pass under cast-iron posts *CC*, about 4 inches high, two to each rod; the ends of the rods pass through washers *DD*, which cover the ends of the bolster and take both rods. These washers are made of either cast or malleable iron or pressed steel.

To each side of the bolster at each end are bolted the bolster guide blocks *EE*, by means of three $\frac{1}{2}$ -inch bolts, passing through the bolster and having double nuts. The bolster is gained out to receive the raised part of this casting, the corresponding depressed part working over the column guide bar, and keeping the bolster from moving laterally.

The truck center plate *FF* is bolted to the bolster by means of four $\frac{1}{2}$ -inch bolts, and is provided with lugs or dowels and some-

times with flanges on its side to prevent its displacement and to relieve the bolts.

Different styles of center plates are in use which were explained, under the head of body bolsters.

The side bearings *GG* are made of proper height to allow a space of from $\frac{1}{4}$ to $\frac{1}{2}$ inch between the body and truck side bearings when the car is empty and on a straight track, and are fastened to the bolster by means of two $\frac{1}{2}$ -inch bolts. Other styles of side bearings are in use, which have already been described under the head of body bolsters.

In Figs. 46 and 47 is shown a truck bolster made of bars of flat iron bent to form a truss. *A* and *B* are the upper and lower bars, made of $\frac{3}{4}$ and $\frac{1}{2}$ -inch iron respectively, each being 12 inches wide. The bars are bent as shown, and are tied together by $\frac{1}{2}$ -inch bolts passing through malleable iron distance pieces *C*, *D* and *E*; some of these bolts are also utilized to hold the centreplate and side-bearings. The lower bar is upset on the ends, forming lugs for the upper bar to bear against. There is considerable strain on the bolts in this construction, and it has been found necessary to make the fit in the holes a good one to prevent their breaking. The two bolts in the outer ends should be turned and driven in.

The ends of the bolster are provided with malleable castings *FF*, paving flanges which guide the bolster in its vertical motion on the bolster column, and also have pockets on their lower sides for the bolster springs to rest in. Side bearings *GG* and center *H* are provided as usual.

Cast steel is used to some extent for truck bolsters, and the cross-sections having the maximum strength for the minimum weight are adopted, which are the channel bar and the I-beam sections,

Figs. 48 and 49 showing one of the latter kind, the section being shown at A. The spring pockets *DD* and guides for the column bars *EE* are cast in one piece with the bolster and the center plate *F* and side bearings *GG* are sometimes also made part of the same casting, although usually they are bolted on, so that their height may be adjusted when it is necessary to change the height of the car. The center plate shown has a hub on the bottom, around the center-pin hole, which rests in a corresponding recess in the bolster, and thereby relieves the bolts of considerable strain.

The bolster shown in Figs. 50, 51 and 52 is made entirely of pressed steel, riveted together by $\frac{1}{4}$ -inch rivets. The two sides *AA* are pressed in the shape of channels and are connected by means of center braces *B* and *C*, and end braces *DD* and *EE*. The bolster guide blocks *FF* are also made of pressed steel and riveted in place. A spring plate *GG* is riveted on the lower side of each end, where it rests on the bolster springs. Side bearings *HH* and center plate *I* of pressed steel are also riveted on and assist to tie together the two sides of the bolster.

(To be Continued.)

The Effect of High Rates of Combustion Upon the Efficiency of Locomotive Boilers.*

BY PROF. W. F. M. GOSS.

The experiments with which this paper is concerned were carried out a few months ago in the locomotive laboratory of Purdue University. They are here presented by a brief and very general description of the work, together with a discussion of some of its most significant results, and by two appendices which give the more technical descriptions, Appendix I dealing with the apparatus and methods employed, and Appendix II giving a summary of all observed and calculated data.

The problem to be studied by means of the experiments will be more readily appreciated if it is remembered that the boiler of any given locomotive is most efficient when worked at the lowest power practicable; that, is when the rate of combustion in its firebox is minimum. For the development of a higher power, the rate of combustion must be increased, and, as a result, the efficiency of the boiler is lowered.

The relation between the rate of combustion and the weight of water per pound of coal for the Purdue locomotive "Schenectady," while using Brazil block coal, is shown by Fig. 1.† From this diagram it appears that when coal is burned at the rate of 50 pounds per square foot of grate per hour, eight pounds of water are evaporated for each pound of coal; while if the rate of combustion is increased to 180 pounds per foot of grate, the evaporation falls to about five pounds—a loss in water evaporated per pound of coal of nearly 40 per cent. This loss may be due to a failure of the heating surfaces to absorb properly the increased volume of heat passing over them, or to the imperfect combustion of the fuel upon the grate, or it may be due to a combination of these causes.

That a portion of the loss occurs along the heating surfaces hardly admits of question, since it is well known that any increase in the rate of combustion results in a rise in the temperature of the smokebox gases; but whether, under ordinary conditions, any considerable portion of the loss shown by Fig. 1 is due to imperfect combustion, has not been demonstrated,‡ and it is this question especially that the present paper attempts to treat.

The importance of the subject is emphasized by the varying practice of locomotive designers, who, in some cases, have so designed large boilers as to allow a large grate, while in others they have forced the combustion beyond limits which had hitherto been customary.

It will be seen that a separation of the losses which may occur at the grate from those which take place along the heating surface could not be accomplished by boiler tests alone, because the results of such tests give the combined effect of both these losses. There are two variables involved, and in order that either may be deter-

mined one must be given a constant value. In the tests described, action along the heating surface was maintained constant, while conditions at the grate were varied.

As a preliminary step, a number of tests were outlined in which the total weight of fuel fired was to be constant throughout the series, while the rate of combustion was to be made different for each test by changing the area of grate. It is evident that if the action at the grate were equally efficient during the several tests—that is, for different rates of combustion—this provision would cause the same volume of heat to pass over the heating surfaces of the boiler, and hence would produce the same evaporation and the same smokebox temperature. If, on the other hand, the combustion should prove less efficient for any one test than for others, a smaller volume of heat would sweep the heating surface, less water would be evaporated, and the smokebox temperature would probably be lower.

The outline provided for all observations usual in boiler testing, and, in addition to these, for a determination of the weight of fuel lost in the form of sparks; and for chemical analyses of the fuel used, of the sparks caught and of the smokebox gases. A more complete description of the apparatus used and the methods employed will be found in Appendix I.

The first test was run with the locomotive under normal conditions. The whole grate was covered with fuel, the throttle was fully open, the cut-off approximately 6 inches, and the load such as to make the speed 25 miles per hour. These conditions gave a rate of combustion of 61 pounds of coal per square foot of grate per hour.

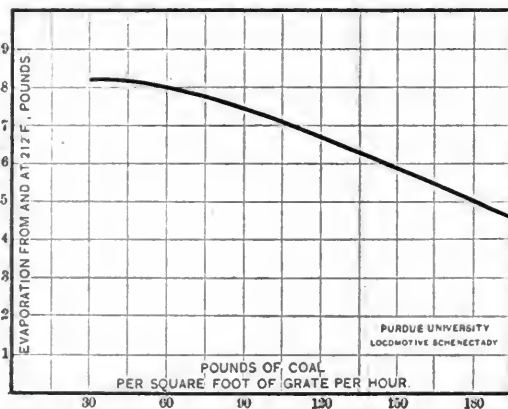


FIG. 1.

In preparation for the second test, one-quarter of the grate was made non-effective, or "deadened" by a covering of fire-brick. The exhaust tip was reduced, so that, while the engine was running as before and using approximately the same amount of steam, the same total weight of fuel could be burned on the reduced grate as in the first test had been burned on the whole grate. Trial tests were run until it was known that the changes made would permit the desired conditions to be maintained. The rate of combustion in this test was 84 pounds per square foot of grate area.

In preparation for the third test, the grate surface was reduced to half its original area, and the rate of combustion was increased to 124 pounds per square foot of grate area; and during the fourth test only one-quarter of the original grate was used, the combustion in this case rising to 341 pounds per square foot of grate surface.

It should be evident from what precedes that the prescribed conditions were designed to make each test a duplicate of every other test, excepting in the matter of grate area, this being the one variable for the series.

The coal used in the several tests was of uniform quality, the chemical analyses (Appendix II.) showing no greater variation than might occur in different samples from a single shipment. The maximum weight of coal fired per hour in any test was 1,097 and the minimum was 1,038, a difference of less than 50 pounds in more than 1,000, while the variation during three of the four tests does not exceed 1.2 per cent. of the weight fired. All firing was done by one man, the attendants engaged in taking the more important observations were the same for all tests, and

* From a paper read before the New York Railroad Club Sept. 17, 1896.
† Fig. 1 is reproduced from the Proceedings of the Western Railway Club, 1895.

‡ This question has been very ably discussed by Mr. W. H. Marshall, in an editorial which appeared in the January (1896) number of the *Railway Master Mechanic*.

all external conditions affecting the action of the boiler were uniform throughout the series.

The one variable for the series—namely, a different rate of combustion, was secured by keeping constant the weight of coal fired and by varying the area of the grate. There were burned each hour on each square foot of effective grate surface, 61 pounds during the first test, 84 during the second, 124 during the third and 241 during the fourth. These values more than cover the entire range of rates usual in locomotives.

Evidence of losses at the grate with increased rates of combustion is to be found in the record of water evaporated per pound of coal, which, for the several tests, is as follows:

1. Number of test.....	1	2	3	4
15. Rate of combustion; pounds of coal per foot of grate surface.....	61	84	124	241
50. Equivalent evaporation from and at 212 degrees Fahr.; pounds of water per pound of coal.....	8.26	7.87	7.52	6.67
Loss of evaporation in terms of equivalent evaporation for test No. 1.....	.....	4.7	9.0	19.2

In consideration of all the conditions governing the experiments, it would seem fair to assume that the decrease of 19 per cent. in the weight of water evaporated, a result which comes from increasing the rate of combustion from 61 to 241, is a loss which occurs wholly at the grate.*

The preceding paragraph exhibits a measure of the loss which occurred at the grate of the boiler tested, when the rate of combustion was increased above 61 pounds. A large fraction of this loss is to be accounted for by the escape of sparks, and it is significant that, as the sparks increase in volume, their heating value also increases. (Item 34.)

By reducing the weight of sparks to an equivalent weight of coal, on the basis of their relative heating value, it is possible to make the following comparison:

1. Number of Test.....	1	2	3	4
15. Rate of combustion.....	61	84	124	241
11. Total pounds of sparks per hour.....	1,071	1,078	1,488	1,438
Total pounds of sparks per hour.....	61.5	95.1	128.6	176.3
Pounds of coal equivalent to spark losses per hour.....	46	77	111	161
Value of spark losses in per cent. of coal fired.....	4.3	7.2	10.2	15.5

According to popular judgment, the loss of heat by sparks has always appeared small; while the data show that under conditions which are now common, it may represent more than 10 per cent. of the fuel value of coal fired. It is evident, however, that these losses will, in general depend very much upon the quality of coal and it should be noted that the Brazil block which was used in the tests under consideration is quite friable.

Without attempting a full discussion of the analyses of the smokebox gases (Items 37-41), attention may be directed to two important facts. These are, first, the large percentage of oxygen shown, indicating a supply of air greatly in excess of that required for combustion; and, secondly, the absence of carbon-monoxide (CO) in all excepting the last test.

All air admitted to the furnace in excess of that required for combustion is heated from the temperature of the atmosphere to that of the smokebox, and by this process heat is taken from the furnace. As the data show an increasing amount of air during the third and fourth tests of the series, it would appear that this cause must have operated to reduce the performance of the boiler as the rate of combustion was increased.

The presence of carbon-monoxide (CO) in the smokebox gases is accepted as proof of imperfect combustion. This gas, as already noted, occurs only in Test No. 4. It has long been supposed that its formation is due thick firing, and its failure to burn after it is formed to deficient air supply, or to a temperature too low to ignite it. Upon this theory, its presence in Test No. 4, and its absence in the other three, are difficult to explain.

In contradiction of the old theory, however, Herr R. Ernst† has recently shown that the amount of this gas (CO) formed in the combustion of carbon depends upon the temperature of the fire; that, as the temperature of the fire is increased, a larger proportion of the carbon is converted into CO, until under very high rates of combustion, or, more specifically, when the temperature of the fire

is above 1,800 degrees Fahr., the first process of combustion is the entire conversion of the carbon into this gas. He has also shown that this gas will not burn, even in the presence of air, so long as its temperature is above 1,800 degrees Fahr.; it must be cooled before it will burn. Herr Ernst argues that, for high rates of combustion, there should be a rapid transfer of the heat liberated from the combustion chamber, in order that the carbon-monoxide formed may be sufficiently reduced in temperature to burn. This theory points to the possibility of heavy losses through the formation and non-combustion of carbon-monoxide in the locomotive firebox, in which very high rates of combustion are maintained, but the results of the Purdue experiments are reassuring. It must be admitted, however, that the relation of grate surface to firebox volume, during all but the first test, gave conditions which more nearly satisfy those prescribed by Herr Ernst than would exist had the same rates of combustion been maintained on a full grate. On the other hand, it may be urged that the rate of combustion maintained in Test No. 4 was higher than any which can be found in practice, a condition which would tend to neutralize the advantage of a large firebox. But, theory aside, the fact remains that the tests show very small losses by imperfect combustion, even when the rate of combustion is highest.*

CONCLUSIONS.

The results show that the most efficient furnace action accompanies the lowest rates of combustion; and while the precise relationships established by the experiments may not hold for fuel which is different from that employed, nevertheless they enforce the general conclusion that very high rates of combustion are not desirable, and, consequently, that the grate of a locomotive should be made so large that exceptionally high rates will not be necessary. They emphasize, also, the importance of spark losses, which, during the experiments under discussion, practically equalled in value all other losses occurring at the grate.

Leaving the conditions peculiar to the experiments, and assuming that the results obtained from them may be applied to the locomotive "Schenectady," when working under normal conditions, we find that the losses in evaporative efficiency which occur when the rate of combustion is increased above 50 pounds may be accounted for approximately as follows: The relation between the rate of combustion and the water evaporated per pound of coal, under nor-

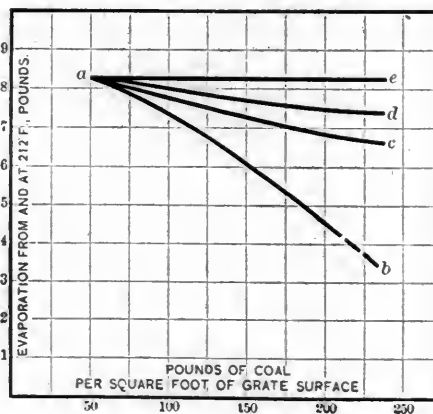


FIG. 2.

mal conditions, is represented by the line *ab*, Fig. 2. If it could be assumed that the heat developed in the furnace would be absorbed with the same degree of completeness for all rates of combustion, the evaporation would rise to the line *ac*; if in addition to this it could also be assumed that there were no spark losses, the evaporation would rise to the line *ad*; finally, if, in addition to these, it could be assumed that there were no losses by the excessive admission of air, or by incomplete combustion, then the evaporation would remain constant for all rates of combustion, and would be represented by the line *ae*.

That is, with the boiler under normal conditions, the area *abca* represents the loss occasioned by deficient heating surface, the area

* The fact that the plan of the tests did not allow the boiler to develop the same power during all tests, may give rise to a question concerning the accuracy of this statement; it may be said that a portion of the effects produced is due to changes in power. Against such an objection, it may be urged that changes in power were comparatively slight, and it can be shown that their influence would diminish, rather than increase, the difference in the observed results. It is, therefore, safe to say that the losses at the grate are not less than those given.

† "The Principles of Combustion," a paper by R. Ernst, published as an inaugural dissertation at the University of Giessen, Hamburg, 1892. (See *The Engineer*, London, Aug. 4, 1893.)

* In a list of nine analyses of locomotive smokebox gases, selected by Mr. Kent from a large number made by Mr. P. H. Dudley, three exhibit CO. The amount varies from one per cent. to 2.5 per cent.

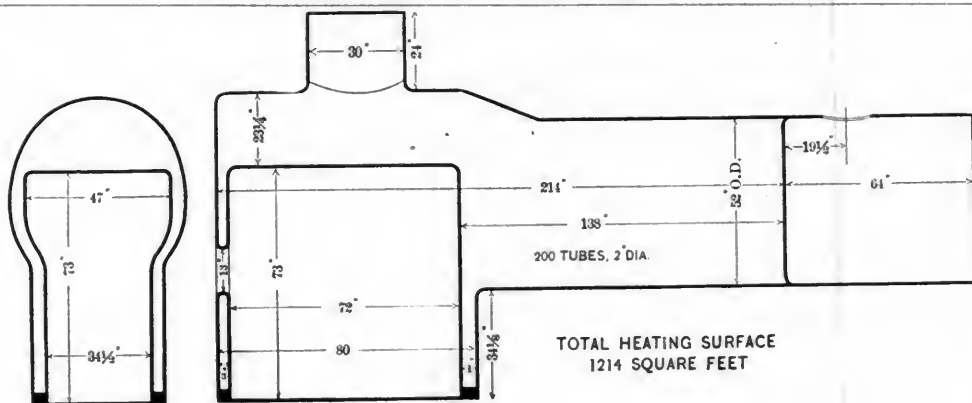


FIG. 3.

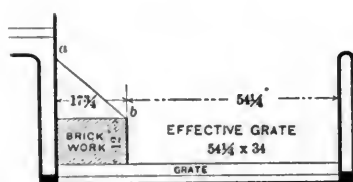


FIG. 4. TEST 2.

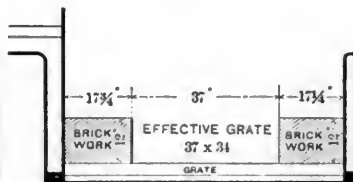


FIG. 5. TEST 3.

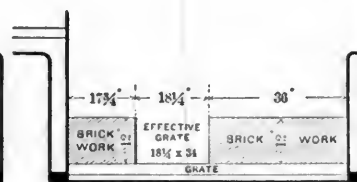


FIG. 6. TEST 4.

Boiler and Grates Used in Testing Efficiency of Different Rates of Combustion.

a c d that occasioned by spark losses, and the area *a d e* that occasioned by excessive amounts of air and by imperfect combustion.

APPENDIX I.

APPARATUS AND METHODS.

The experiments discussed in the foregoing paper were conducted by Mr. Alfred R. Kipp, in conjunction with Mr. Richard A. Smart, who, as Instructor in the Engineering Laboratory, had immediate charge of the work. All chemical analyses were made by Mr. Charles D. Test, under the direction of Prof. W. E. Stone, in charge of the Purdue Chemical Department.

The apparatus employed constitutes a portion of the permanent equipment of the locomotive laboratory of Purdue University, but this experimental locomotive plant has been so many times described that it does not in this place require special description. The locomotive is of the eight-wheeled type, with 17 by 24-inch cylinders, and weighs 85,000 pounds. The boiler, with which the present work especially concerns itself, is shown in outline by Fig. 3.

The deadening, which was employed to cut out portions of the grate, was of brick laid up in fire-clay, the effect being to make the covered portions of the grate as nearly air-tight as possible. The material extended across the breadth of the firebox, the sections of the grate covered being disconnected from the rocking mechanism, so that the remainder could be used with undiminished effect. Its distribution during the several tests is shown by Figs. 4, 5 and 6, respectively.

Early in the second test, ash piled up on the deadening, as indicated by the line *a b*, Fig. 4; but as the accumulation did not reach the lower tubes, it was not dislodged. At the end of the test, everything in the firebox which was not coal was credited to ash. During the third test there was less of this deposit, and during the fourth still less, an effect probably due to the presence of a stronger draft.

The thickness of fire for each test was not greater than was necessary to the easy maintenance of the steam pressure. The firing was always at regular intervals, and usually only three shovelfuls were thrown in at one time. In the fourth test the thickness of the fire equaled that of the deadening (Fig. 6).

The samples of smokebox gases for analyses were drawn from a point near the center of the smokebox. Ten minutes were occupied in obtaining the sample, a period sufficiently long to cover all conditions of fire.

The smokebox temperatures were obtained by means of a Le Chatelier pyrometer, an instrument constructed on the thermopile and galvanometer principle, and which, for comparative work, is very reliable. The differences in temperature recorded are probably correct within less than one per cent.

The weight of sparks or cinders passing the heating surface is the sum of those caught in the front end of the locomotive and those passing out at the top of the stack. The sparks which accumulated in the front end were easily collected and weighed. Of those which passed out of the stack, a portion only were collected, the sample being so chosen as to serve as a basis from which the value of the whole could be estimated. The apparatus employed in this latter process is shown by Fig. 7. It consists of an inverted U-tube of galvanized iron, securely fastened to a movable frame, by means of which the tip, which constitutes one extremity of the tube, can be projected across the top of the locomotive smokestack. The outer end of the tube may thus be made completely to intercept a portion of the stream issuing from the

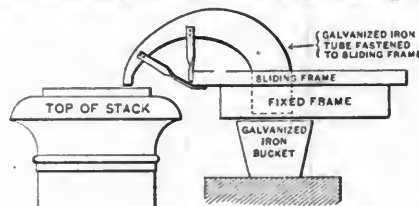


FIG. 7. SPARK TRAP.

stack, and the continuous action of this stream is sufficient to drive the intercepted portion through the tube and out at the other end. The gases passing the tube bear the sparks on their current, and they are collected in a bucket set to entrap them. Reference marks upon the sliding and the fixed frames permit the tubes to be placed in definite locations relative to the center of the stack. This device, when in service, catches everything excepting the lightest soot, which is allowed to escape unaccounted for.

After assuming the cross-section of the stream issuing from the stack to be cut up, by a series of concentric circles, into one circular and several annular areas, as shown by Fig. 8, the small end of the

(tube was placed in the position marked *I* and held there for 30 minutes, the sparks collected during this interval being credited to this position. The tube was then moved to the position *II*, where it remained for another period of 30 minutes. In like manner, it was made to occupy, successively, the positions *III* and *IV*, and also the positions *I*, *II*, *III*, and *IV*, the weight of sparks caught during each interval being credited to the corresponding position occupied by the small end of the tube. This end of the tube had an area of one square inch, and it was assumed that the average weight of sparks passing the tube while in the positions *I* and *I*, would be the same as that passing every square inch in the annular space in which these positions are located. For example, the outer annular area, in which *I* and *I*, are located, contains 88 square inches. If, in half an hour, 0.5 pound was collected by the tube in the position *I*, and in another half hour 0.3 pound was collected from the position *I*, the sum of these two weights, or 0.8 pound, collected during a period of one hour would be the average weight per square inch per hour collected from the two positions, and the weight for the whole outside annular area would be 0.8 times 88, the number of square inches, or 70.4 pounds per hour. A similar experiment and calculation gave the weight per hour delivered by each of the other annular areas *II* and *III*, and by the circular area *IV*. The sum of these separate determinations was assumed to be the total weight of sparks per hour delivered from the stack.

Other accessory apparatus employed was such as is commonly used in boiler testing, and therefore need not be described.

The engines of the locomotive were not involved in the tests, excepting as they served to shake the boiler, to furnish draft and to consume the steam generated. While the speed was varied slightly in different tests as a means by which desired rates of combustion might be the more readily secured, it was approximately 25 miles per hour for all tests. The running for each test, therefore, was equivalent to 150 miles.

In running the tests, regular observations were made at the beginning, and at five-minute intervals thereafter, giving 73 series of observations, upon the average of which the data are based. Exceptions to this rule are, however, to be made in the case of the spark record, to which reference has already been made, and in the case of the draft record, which was obtained by readings each minute during the first 20 minutes of every hour.

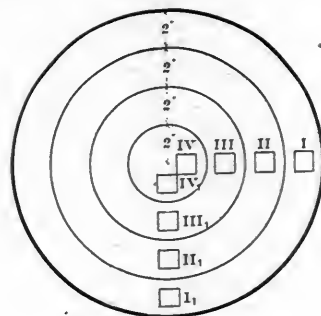


FIG. 8.

Test Number.....	1	2	3	4
30. Total-pounds of sparks for test.....	369.	571.	772.	1058.
31. Pounds of sparks per square foot of grate per hour.....	3.5	7.3	14.7	41.0
32. Pounds of combustible in sparks for test.....	242.	395.	576.	837.
33. Percentage of fixed carbon in sparks dry and free from ash.....	94.	94	95.	96.
34. Approximate B. T. U. per pound of sparks.....	9870.	10360.	11290.	11880.
35. Pounds of coal equivalent in heating value to one pound of sparks.....	0.75	0.80	0.86	0.91
36. Pounds of coal equivalent in heating value to total weight of sparks for test.....	277.	457.	664.	963.
<i>Analysis of "Smoke-Box Gases."</i>				
37. Per cent. carbon dioxide.....	5.25	6.25	4.80	1.80
38. Per cent. heavy hydro-carbons.....	0.50	0.40	0.40	0.50
39. Per cent. oxygen.....	12.15	11.80	14.60	18.70
40. Per cent. carbon monoxide.....	0.00	0.00	0.00	0.55
41. Per cent. nitrogen.....	81.90	81.55	80.20	78.45
<i>Other "Smoke-Box Data."</i>				
42. Diameter of Double Exhaust tip.....	3.	2.75	2.35	1.75
43. Draft in inches of water.....	2.2	2.5	3.3	5.6
44. Temperature of smoke-box, degrees F.....	647.	629.	610.	500.
<i>Water and Steam</i>				
45. Pounds of water delivered to boiler.....	44756.	43081.	40710.	43770.
46. Temperature of feed, degrees F.....	54.0	53.0	53.5	52.7
47. Boiler pressure, by gage.....	129.4	127.2	127.2	129.1
48. Quality of steam in dome.....	0.982	0.981	0.984	0.983
<i>Evaporation.</i>				
49. Pounds of water evaporated per pound of dry coal.....	6.94	6.60	6.30	5.58
50. Equivalent evaporation from and at 212° F.....	8.26	7.87	7.52	6.67
<i>Horse Power.</i>				
51. Horse power of Boiler.....	257.	248.	226.	201.
52. Horse power per square foot of grate.....	15.	19.	26.	47.
<i>Approximate Efficiency.*</i>				
53. Ratio of heat developed in the furnace to heat absorbed by water.....	0.61	0.59	0.56	0.50

* All chemical analyses were made under the direction of Professor W. E. Stone, Charles D. Test, A. C.

† The efficiency is approximate only, since the heating value of the coal is only approximately known. Since the same coal was used for all tests, there can be no error in using this factor for purposes of comparison within the limits of the present series of tests.

Our esteemed contemporary, the *Iron Age*, has removed its offices from 96-102 Reade street to 232-238 William street, New York.

The offices of the Colliery Engineer Company, proprietors of *The Colliery Engineer* and *Metal Miner*, Home Study, and the International Correspondence Schools, in the Coal Exchange Building, Scranton, Pa., were partially destroyed by fire on Sunday morning, Aug. 30, 1896. Fortunately the printing plant was in another building, and the reserves of all instruction and question papers, drawing plates and other supplies and stationery used in the schools in still another building, so that its business will not be seriously interfered with.

APPENDIX II.

OBSERVED AND CALCULATED DATA.

1. Test Number.....	1	2	3	4
2. Month and day (1896).....	Feb. 8.	Feb. 11.	Feb. 15.	Feb. 22.
3. Duration of test, hours.....	6.	6.	6.	6.
4. Approximate portion of whole grate used.....	Full.	Three-fourths.	Half.	One-fourth.
5. Exact area of effective grate square feet.....	17.50	13.01	8.74	4.31
6. Barometric pressure, pounds..	14.41	14.43	14.34	14.47
<i>Analysis of Coal.*</i>				
7. Per cent. fixed carbon.....	49.65	51.84	51.09	51.59
8. Per cent. volatile matter.....	49.29	39.00	38.93	38.87
9. Per cent. combined moisture.....	3.15	3.62	2.35	3.44
10. Per cent. ash.....	6.91	5.54	7.63	6.10
<i>Coal [Brazil Block].</i>				
11. Pound fired.....	6522.	6628.	6716.	6328.
12. Weight of water in each pound of coal fired.....	0.012	0.016	0.030	0.012
13. Pounds of dry coal for test.....	6443.	6522.	6514.	6227.
14. Pounds of dry coal per hour.....	1074.	1087.	1086.	1038.
15. Pounds of dry coal per hour per square foot of grate.....	61.4	83.5	124.2	240.8
16. Pounds of combustible for test.....	5792.	5921.	5856.	5635.
17. Percentage of fixed carbon in coal, dry and free from ash.....	56.	57.	57.	57.
18. Approximate number of B. T. U. per pound of combustible.....	13800.	14040.	14040.	14040.
19. Approximate number of B. T. U. per pound of dry coal.....	13000.	13000.	13000.	13000.
20. Theoretical evaporation from and at 212° per pound of dry coal.....	13.46	13.46	13.46	13.46
<i>Ash.</i>				
21. Pounds of dry ash in ash-pan for test.....	446.	396.	297.	164.
22. Pounds of ash in coal fired as shown by analysis of coal.....	445.	361.	497.	380.
23. Pounds of ash by analysis, minus pounds found in ash-pan.....	-1.	-35.	200.	216.
<i>Analysis of Sparks.*</i>				
24. Per cent. of fixed carbon.....	61.74	64.88	71.32	76.44
25. Per cent. volatile matter.....	4.36	4.16	3.45	3.29
26. Per cent. combined moisture.....	1.82	1.82	1.66	1.86
27. Per cent. ash.....	32.08	29.14	23.57	18.41
<i>Sparks.</i>				
28. Pounds caught in front-end during test.....	75.	213.	494.	566.
29. Pounds passing out of stack for test.....	294.	358.	278.	492.

* All chemical analyses were made under the direction of Professor W. E. Stone, Charles D. Test, A. C.

(Established 1832.)

AMERICAN ENGINEER CAR BUILDER AND RAILROAD JOURNAL.

27TH YEAR.

65TH YEAR.

PUBLISHED MONTHLY

BY
R. M. VAN ARSDALE,

MORSE BUILDING.....NEW YORK.

M. N. FORNEY,
W. H. MARSHALL, } Editors.

R. G. CHASE, 705 Western Union Building, Chicago.

OCTOBER, 1896.

Subscription.—\$2.00 a year for the United States and Canada; \$2.50 a year to Foreign Countries embraced in the Universal Postal Union.

EDITORIAL ANNOUNCEMENTS.

Advertisements.—Nothing will be inserted in this journal for pay, EXCEPT IN THE ADVERTISING PAGES. The reading pages will contain only such matter as we consider of interest to our readers.

Special Notice.—As the AMERICAN ENGINEER, CAR BUILDER AND RAILROAD JOURNAL is printed and ready for mailing on the last day of the month, correspondence, advertisements, etc., intended for insertion must be received not later than the 25th day of each month.

Contributions.—Articles relating to railway rolling stock construction and management and kindred topics, by those who are practically acquainted with these subjects, are specially desired. Also early notices of official changes, and additions of new equipment for the road or the shop, by purchase or construction.

To Subscribers.—The AMERICAN ENGINEER, CAR BUILDER AND RAILROAD JOURNAL is mailed regularly to every subscriber each month. Any subscriber who fails to receive his paper ought at once to notify the postmaster at the office of delivery, and in case the paper is not then obtained this office should be notified, so that the missing paper may be supplied. When a subscriber changes his address he ought to notify this office at once, so that the paper may be sent to the proper destination.

The paper may be obtained and subscriptions for it sent to the following agencies: Chicago, Post Office News Co., 217 Dearborn Street, London, Eng., Sampson Low, Marston & Co., Limited St. Dunstan's House, Fetter Lane, E. C.

CONTENTS.

ILLUSTRATED ARTICLES:	Page.	EDITORIALS:	Page.
The Altoona Shops of the Pennsylvania Railroad.....	241	Use of Buffer Blocks with Vertical Plane Couplers.....	259
Performance of a 500-Horse Power Laval Steam Turbine.....	245	Defects and Improvements in Locomotives.....	260
United States Armored Cruiser Brooklyn.....	249	The Good Works of the Technical Press on the Money Question.....	261
Construction and Maintenance of Railway Car Equipment.....	251	MISCELLANEOUS:	
Effect of High Rates of Combustion upon the Efficiency of Locomotive Boilers.....	254	A Novel Method of Obtaining Dynamometer Cards.....	246
Why an Electric Motor Involves.....	263	Tests of Car Wheels.....	246
Mogul Freight Locomotive for the New York, New Haven & Hartford R. R.....	267	A New Railroad Club.....	246
Locomotive for Burning Petroleum Fuel.....	268	Subjects for 1897 Conventions.....	246
The Most Advantageous Dimensions for Locomotive Exhaust Pipes and Smokestacks.....	270	Facts and Opinions on the Design of Express Locomotives.....	247
Lidgerwood Cableway at Hale Hawaiian Islands.....	275	Engineering Notes.....	262
Heavy Milling Machine for Locomotive Works.....	276	Personals.....	263
Oil Tube Drills.....	277	J. F. Holloway.....	264
EDITORIALS:		Equipment Notes.....	264
Notes to Advertisers.....	258	Fire-Retarding Qualities of Wire-Glass.....	265
Not Politics, but Business, Honesty and Patriotism.....	258	Western Railway Club.....	267
Leading Trucks for Express Locomotives.....	259	Electric and Compressed-Air Locomotives for the Manhattan Elevated Ry.....	268
The New Cruiser Brooklyn.....	259	The New U. S. Battleships.....	269
European Ignorance of American Practice.....	259	Spontaneous Ignition of Coal.....	269
Tests of a 300-Horse Power Turbine.....	259	Central Railroad Club.....	274
		New Publications.....	274
		Books Received.....	274
		Trade Catalogues.....	274
		Relative Cost of Iron and Copper as Conductors.....	275
		The Gas Exposition at New York.....	276
		La Villa Heaters.....	277
		Manufacturing Notes.....	277
		Our Directory.....	278

NOTICE.

To manufacturers and business men who want to prepare at once for the improvement in business that will result from the defeat of free silver on Nov. 3d, and who yet hesitate to incur any new obligations at present, we make the following proposition:

To those who make advertising contracts with us before Nov. 3d we will agree to publish their advertisements for one year on the condition that if Mr. McKinley is elected President they will pay for them at the regular prices, but if Mr. Bryan is elected, their advertisements in this journal will be free of charge for the period covered by their contracts.

We have enough faith in the result of the campaign of education now going on, in which the railroad technical press is taking such a creditable part, to make this offer to those who still hesitate to resume business activities.

BUSINESS, HONESTY AND PATRIOTISM.

If the present unsatisfactory condition of business were the temporary result of political agitation and of politics only, we would not feel that it was the province of this journal to take sides or express any opinion on the issues involved. But the present crisis in our national and individual affairs has been brought about not by politics but by an avowed determination of persons ignorant of the natural laws of finance and commerce to overthrow our present coinage system and (if they get the chance) launch this country upon a dangerous sea of financial experiment and theory which can only end in disaster and ruin. The mere announcement of such a programme has applied the brakes to all enterprise and trade expansion, and brought to a standstill everything that could stop. The result would have been the same if any other party of sufficient power had advocated free coinage of silver, for in commercial and financial affairs, just as truly as in railroading, a danger signal is an order to stop, irrespective of who set the signal.

Most of our readers are employed by, or are interested in, railroads and industrial and manufacturing enterprises. If the proposed free-silver legislation is ever carried into effect their interests will be hit promptly and hit hard, and that, too, without any definite gain to the country at large, but with certain disaster. We do not need to tell our readers that their interests are already affected. Railroad reports for the year ending June 30, 1896, taken as a whole, show that railroads had recovered from the depression of the two or three years immediately preceding, and were enjoying a business that had seldom, if ever, been exceeded in their history. Their purchases of material were heavy, and concerns supplying it were prosperous. The great volume of the transportation business indicated returning prosperity in all directions.

The first of the political conventions gave an added impetus to business because it declared for a gold standard. One of the largest builders of machine tools told us last week that the orders his firm received during the month of that convention were the largest in its history. Then followed the other conventions, with their platforms threatening the stability of our currency, and even of the government itself. The danger signals were set and things stopped moving. They stopped so quickly that, to quote again the experience of the concern above mentioned, it received that month just one-fifth as many orders as in the preceding month, and now it has none.

Our readers are practical men who in technical affairs refuse to base their actions on theories not supported by facts. In the present campaign against sound money, many glowing promises are given and attractive theories promulgated that are not supported by facts. We don't for a moment believe that they will be entertained.

It is claimed that under the free coinage of silver at a ratio of 16 to 1, silver will rise in bullion value to \$1.29 per ounce, and that our gold and silver currency will circulate at equal value as now. If such an absurdity could be brought to pass what would be accomplished? Simply that the silver-mine owners of the world who are now selling 175,000,000 ounces of silver annually for

about \$114,000,000 and realizing a handsome profit thereby, would receive for this bullion \$235,750,000, or an additional profit of \$111,750,000; furthermore, as if that were not enough for these favored persons, the taxpayers in these United States will generously pay the expense of coining as much of this bullion as the owners of it desire to have coined. After coining it, the money will be placed in the hands of the bullion owners and they will say how and when it goes into circulation. Does any one for a moment suppose that those millions of additional profit would ever reach the pockets of the great body of our citizens working for salaries and wages on any more favorable terms than the present dollars do? If not, why should we vote these enormous profits into the pockets of any one class of citizens or of foreigners?

But as the price of silver will not rise to the value of \$1.29 per ounce—for the pages of history bristle with facts that say it will not—then the proposed legislation is positively dishonest. For us, either as a nation or as individuals, to borrow 100-cent dollars and to deliberately pay back our obligations in dollars worth only 50 cents, is so rankly dishonest that we do not believe the citizens of this nation, whose proud record is that it has always stood for fair dealings among the nations of the earth, will ever permit such methods to come to pass.

We have too much faith in the intelligence of our citizens to believe that the result in November will be anything else than a free-silver funeral. And after burying this fallacy so deep that it will never rise again, we can then look forward to years of prosperity for all.

The use of a leading four-wheeled truck under express locomotives is gaining favor in England and on the continent, some believing it the safer construction, while others, not admitting the need of it, use it for the reason that they find the engineers make better time because of their confidence in it. The report on the accident which occurred last May on the North British Railway also contains an argument in favor of the leading four-wheeled truck. The accident was caused by the expansion and consequent lateral deflection of the rails by the excessive heat of the sun at that time. Lieutenant-Colonel Yorke, reporting to the Board of Trade, says: "The fact that the engine did not leave the rails, although the rest of the train did, may probably be attributed to the flexibility imparted to the engine by the leading bogie, which was able to adjust itself to the irregular curvature of the lines produced by the expansion of the rails, whereas the tender, with its six wheels and rigid wheelbase, was most probably the first vehicle to leave the metals and dragged the rest of the train after it."

The new cruiser *Brooklyn*, built for the United States government by the Cramps, and illustrated elsewhere in this issue, has undergone her official trial trip and developed a speed of 21.9117 knots per hour. This was the average speed over the entire course of more than 80 miles, and the maximum speed between two buoys was 22.90 knots. This remarkable performance is a source of gratification to both the builders and the government. It speaks well for the ability of the builders and the designers, and it is calculated to awaken feelings of justifiable pride in the hearts of patriotic citizens. Such excellent records also have a money value, not alone to the builders, who in this case earned \$350,000 in premiums, but to the country that foots the bills. The progress of naval construction is so rapid nowadays that vessels which do not come up to the highest standards of speeds and fighting power for their respective classes will soon become obsolete and be no match for later additions to other navies. The production, therefore, of vessel after vessel of speeds approximating that of the *Brooklyn*, or of fighting power and resistance to projectiles like that possessed by the *Indiana* and *Oregon*, puts the United States in possession of men-of-war that to-day excel similar vessels in the other navies of the world, and that are sure to be up to date for many years to come. Thus the tax-paying citizen is assured that for every dollar put into these vessels the best possible return is received.

From the part of a discussion before the London session of the

International Railway Congress published on another page, one can see that much ignorance exists in Europe in regard to many details of American railroad practice. From the discussion on slide valves for express locomotives it would appear that European engineers are exceedingly anxious to use balanced valves, and are only deterred from so doing because of the absence of a satisfactory method of construction. And yet the universal practice in this country is to employ balanced valves on such engines, and they are almost all of the Richardson type. Practice here has become so uniform that it is conclusive evidence of the satisfaction given by this kind of balanced valve in regular service. Before European engineers get discouraged in their search after a good balanced valve, they had better investigate American practice. There is so much incredulity in the minds of these gentlemen regarding the statements of American doings, fostered probably by the spread-eagle style of our daily press, that it may explain their neglect to investigate our practice. This incredulity is well illustrated by what Mr. H. S. Haines said in his recent address to the American Railway Association. He stated that "when the American delegates spoke at the London Congress of handling 50 or 100 trains a day, and 30,000 or 40,000 cars a month over a single track, the statements were evidently received as specimens of American brag."

The tests of a 300 horse-power De Laval steam turbine to be found on another page are of considerable interest, not only from the low steam consumption at full load of 17.348 pounds per brake horse-power, and 19.275 pounds per electrical horse-power, but also from the fact that at 89 per cent. of full load the performance was equally good, while at 56 per cent. the water consumption was only 20.22 pounds per electrical horse-power, and at 18½ per cent. of full load it had only risen to 27.35 pounds per electrical horse power. This excellent performance and the small space occupied by the turbine are greatly in its favor, and while the first cost may now be as great per horse-power as for a reciprocating steam engine, there would seem to be a reasonable prospect for a great reduction in the price of the turbine. Against these advantages, actual and prospective, must be placed the high speed of rotation, necessitating gearing that may prove expensive to maintain. The large turbines whose tests are recorded in the article already alluded to, should, in the course of a few years, furnish some valuable experience on this point. Should the gearing for large powers prove subject to break down and expensive to maintain, the turbine may be limited in its usefulness to small powers or to the driving of machinery running at such speeds as not to require the gears at all. It is of interest to note that in the case of dynamos, it may be possible to do this in the not distant future, for at least one large firm manufacturing dynamos and motors is at work upon a motor that will run at a speed of 10,000 revolutions per minute. This motor, if it can be successfully constructed, will be used by the United States government on men-of-war to start the propelling machinery of Howell torpedoes just before they are fired from their tubes. This torpedo is propelled by the energy stored in a small fly-wheel inside of it, made to revolve at a speed of 10,000 revolutions, and at present a steam turbine is the only motor of simple form that is available to rotate the fly-wheel at that speed. But there are serious objections to steam pipes leading to the vicinity of every torpedo tube on the vessel, and hence there is an earnest call for a high-speed motor. If this demand is met it may show the way to the construction of high-speed dynamos capable of being driven directly by turbines.

THE USE OF BUFFER BLOCKS WITH VERTICAL PLANE COUPLERS.

When the railroads of this country began the use of vertical plane couplers in freight service, many cars were equipped with buffer blocks for the better protection of the draft gear and the link and pin couplers then in use. With the introduction of the new couplers the use of these buffer blocks was in a number of cases abandoned and the more expensive couplers allowed to take all the shocks of service without protection. Many railroad officials have thought this policy a mistaken one, but there was one

good defense for it in the fact that the face of the vertical plane coupler is three inches further from the face of the dead wood than the face of the link and pin bar, so that when couplers of the two types were brought together the buffer blocks were non-effective. If two vertical plane couplers were coupled together the blocks would be as effective as when two link and pin couplers were united, but as in the early days of the introduction of the M. C. B. couplers their number was small compared with the old type, it is evident that such buffer blocks as were placed on cars so equipped would seldom be effective in relieving the draw gears of buffing strains. Consequently there was reason in the argument that they could be omitted until such time as the M. C. B. couplers became numerous enough to warrant their use.

It is believed by many that that time has now come, but unfortunately, in the period when the number of roads using buffer blocks diminished, many persons appear to have lost sight of the fact that under the right conditions the blocks would afford a much-needed protection to the couplers; hence it is not easy to arouse an interest in them now. Those who are using them are, however, fully convinced as to the wisdom of the expenditure, for they find the resulting saving in the repairs to draft gears to be remarkable. On a road in the East handling at one point several thousand of its own cars every one of which is equipped with the buffers, and about as many hundred cars of a connecting line not equipped with the buffers, the aggregate repairs to the draft gears is more on the foreign than on the home cars, notwithstanding that the latter are nearly ten times as numerous. The cars are all in the same coal traffic, are quite similar in construction, and there does not seem to be any reason for the difference in the cost of repairs except the absence of buffers in the one case.

It does not seem unreasonable to conclude that when all cars are equipped with M. C. B. couplers, the use of buffer blocks would permit a lighter construction of the coupler so that part of the metal now put in the coupler to meet buffing strains, will be transferred to the buffer blocks, where it can better perform its proper function of protecting the draft rigging. If this is the case, the actual cost of the buffers will not be as great as might appear. Certain it is that the method of taking the buffing shocks upon the bracket of the coupler, over an area so small as to rapidly break down the fibers of the end sill and to bend any plate or angle iron used to protect the sill, and at an average distance of at least 4½ inches above the center of the stem, by which leverage fractures through the stem back of the head are deliberately invited, is wrong in principle, and it is believed that it will ultimately be changed.

The advantages arising from the use of buffer-blocks seems to be so clear that discussion is almost unnecessary. The facts are all in favor of those who use them. But it may not be out of place to call attention to the necessity of preserving the standard distance of 10½ inches from the face of the deadwood or sill to the inner face of the hook, or 8½ inches from the horn of the coupler to the hook. That these figures have not been adhered to is evident from investigations made by several parties. We have before us the results of two sets of measurements made on a large number of different makes of couplers, one set being taken in the West and another in the East. Altogether 35 different kinds of M. C. B. couplers were measured. In some cases the two measurements of one kind of coupler agreed, in others they did not, but giving the manufacturer the benefit of the measurement nearer to the standard, the result may be stated as follows:

1 coupler measured 8 inches from knuckle to bracket.			
1	"	8½	"
1	"	8½	"
2	"	8½	"
17	"	8½	"
1	"	8½	"
8	"	9	"
2	"	9¼	"
1	"	9¼	"
1	"	9¼	"

It might be inferred that the 17 couplers which conformed to the standard included all the couplers extensively used, but such is not the case. Many of the well-known couplers conform to standard, but among the couplers that are over size are a number

of well-known bars. The importance of making all couplers conform to the standard in this respect is so evident that surely the lack of conformity need only be pointed out to be remedied. The couplers that measure from 9 to 9½ inches between the points mentioned will not permit the buffers to become operative until the sill or draft-rigging have been driven in sufficiently to damage and weaken them materially. Hence with such couplers those who apply buffers fail to get the benefit of them, and those who do not employ them would have the same trouble if at any time within the life of those couplers they should change their practice and apply the buffers. Manufacturers may have already altered their patterns to conform to the standard, but regular inspection on this point is desirable.

DEFECTS AND IMPROVEMENTS IN LOCOMOTIVES.

II.

The admirable paper by Professor Goss, which was read and discussed at the meeting of the New York Railroad Club, on Sept 17, and which is reprinted on another page, gives fresh interest to the above subject, the discussion of which was commenced last month. At the meeting referred to the observations took a somewhat wide range, and were not confined alone to the points brought out in the paper, and in reality embraced a good deal of what is implied by the above title. It has always been known that very high rates of combustion are not only not economical, but are very wasteful, but Professor Goss' investigation have established this fact on what seems to be complete scientific proof. But another fact was also brought out in the discussion, which was that in burning bituminous coal if very large grates—such as are used in the Woolten firebox—are employed, that greater economy resulted by covering part of the grate with fire-brick or dead-plates than was attainable with the whole grate open. The demonstration of this fact however, is not as complete, as that presented by Professor Goss. The inference, however, is that while a grate may be too small—and probably most of these now in use are not large enough for economy—yet it is possible to have too much grate surface as well as too little. An average consumption of fuel of 100 pounds per square foot of grate per hour is not unusual—for light trains it is much less. The minimum consumption, probably, is often below ten pounds per square foot per hour. Supposing that the size of the grate was doubled, then the minimum might be less than 5 pounds. The lowest rate of combustion tested by Professor Goss was 61 pounds. It is to be regretted that he did not try the results on evaporation with much lower rates. With the present construction of grates, the question is, what size will give the best average results. A grate of a certain size might be wasteful with very high rates of combustion, but be economical when the engine was not working very hard. On most roads it is only during very short periods of time that locomotives must exert their maximum power. During much the greatest part of the time they are at work the consumption of coal is only at very moderate rates. As the conditions of working are constantly varying, it would seem to be desirable to have a grate whose size could be increased when the engine is working hard, and diminished when the demands are not so great.

Reference has been made in these columns heretofore to an engine of the Columbia type, which Mr. Rhodes, of the Chicago, Burlington & Quincy Railroad, had built, as a sort of experimental engine, to test that form of locomotive, and which was illustrated in the AMERICAN ENGINEER, CAR BUILDER AND RAILROAD JOURNAL for last December. As shown from the illustrations and description of that engine, which were then published, its two driving axles and wheels are in front of the fire-box. The latter could, therefore, be made as wide as might be desired, and as deep as the trailing wheels below it would permit. In reality its inside dimensions were 8 feet 10½ inches long by 5 feet wide. This engine, we learned some time ago, was showing a very marked economy over other engines of similar capacity on the road on which it is running, as we ventured to predict it would.

At the time it was illustrated we called attention to the theory

advanced by Mr. Siemens that combustion is arrested when flame comes in contact with any solid substance, as is illustrated by inserting a wire into an ordinary gas flame. His inference was that it is desirable in all furnaces to keep the flame out of contact with the sides, ends and top of the firebox as long as possible, or until the process of combustion is completed. From this the deduction was drawn that the ideal form for a firebox would be a sphere or a cube—or, in other words, that its length, breadth and height should at least be approximately equal. A very common area of grates of locomotives is from 20 to 25 square feet. In Mr. Rhodes' engine he has nearly 45. Our prediction was based upon Mr. Siemens' theory, and also on our somewhat vague belief in what Professor Goss has since proved by his experiments. The deduction—which has since been confirmed by actual experience—was made from purely scientific data. It was an evolution of science and not of practice, and illustrates the value of science to railroad companies.

At the meeting of the Railroad Club, which has been referred to, a letter was read which was written by Professor Ostwald, a distinguished German chemist, to a fellow professor in England, in which he describes the means adopted in Germany which has enabled manufacturers in that country to compete successfully with Englishmen. Referring to his own specialty, Professor Ostwald said:

"Each large work has the greater part of its scientific staff—and there are often more than 100 Ph. D.'s in a single manufactory—occupied, not in the management of the manufacture, but in making inventions. The research laboratory in such work is only different from one in a university by its being more splendidly and sumptuously fitted than the latter. I have heard from the business managers of such works that they have not unfrequently men who have worked for four years without practical success; but if they know them to possess ability, they keep them notwithstanding, and in most cases with ultimate success sufficient to pay the expenses of the former resultless years."

Commenting on this, the *New York Evening Post* says:

"Is it any wonder that by such methods Germany has come to control the fine chemical markets of the world? By her superiority in this respect alone she is able silently and without any legislation to lay a tax upon almost every industry in every country. German manufacturers have come to a clear understanding of the commercial importance of science. Not long ago one of them offered a university professor a very large salary simply to come into his works and make experiments regarding the practical use of certain scientific methods which the professor had been developing. This close relationship between science and industry is good for both. It puts the best trained and highest inventive power at the service of manufactures, and it also furnishes the scientist not only with new openings for a livelihood, but with wide opportunities for research."

Might it not be wise for some of our railroad companies to follow the example of the German chemists?

In an article published in the *AMERICAN ENGINEER* of December, 1894, it was shown that in the best performance of locomotives the fuel consumption is only half that of the average performance on well-managed roads. A very considerable economy would therefore seem to be possible if railroad companies would take some such steps as the Germans have taken to avail themselves of the greatest economies possible. Referring to the letter quoted the *New York Post* says further:

"Its significance was at once preceived. Here was something deeper and more powerful than tariffs. Here was a frank disclosing of the hiding of German power as a competitor for the world's commerce, with the unavoidable inference that there was but one way to rival it—not by laws or diplomatic manoeuvres, but by meeting knowledge with knowledge and skill with skill."

There is probably no general subject which is now receiving so much attention from railroad managers as that of economy of operation. In many cases this has been a matter of life or death, or "to be or not to be"—in the hands of a Receiver.

To show how this subject appears to a person who regards the subject from the monetary side alone, the following quotation from the financial article of the *New York Times* of Sept. 20 is reprinted. The writer of the article says:

"That the St. Paul railroad managers have but recently discovered how to work their road more cheaply than any other granger road, and far more cheaply than the Lake Shore road, or the Pennsylvania system, not to speak of other large systems; and that this knowledge has been progressively acquired and applied, will appear from the following brief table:

Year.	Ratio.	Gross Earnings.
1893	65.19	\$33,000,000
1894	64.21	31,300,000
1895	62.35	27,300,000
1896	60.21	32,000,000

"Now, if the St. Paul managers had not acquired this knowledge, and had worked their road in the last fiscal year at 65 per cent., the surplus for the common stock would have been just 4.40 per cent., with 4 per cent. paid as dividends. As they were able to do it for a little over 60, they showed 8 per cent. earned. Thus it appears how advantageous it would be if other corporations had St. Paul managers."

We have not undertaken to analyze these figures, or the cost of operating the lines whose expenses are unfavorably compared with those of the St. Paul road, knowing, as we do, how misleading such a basis of comparison may be. Thus at 60.21 per cent. of gross earnings of \$32,000,000 reported for the St. Paul road for 1896, the expenses would have been \$19,267,200. Now suppose the rates for carrying freight and passengers during that period had been increased 10 per cent., the expenses remaining the same, their percentage would then have been only 54.4 per cent. of the earnings. On the other hand, if the rates had been reduced 10 per cent., the expenses remaining the same, then the latter would have been 66.9 per cent. of the earnings. Doubtless under the former state of affairs the wise men who write financial articles for the papers would have commended the managers and in the latter condemned them, while, as a matter of fact, the management would have been just as good in the one case as in the other, and in fact the economy would have been exactly the same in both. The difference of cost in running a passenger train is almost or quite inappreciable whether the trains are filled or not. Cost of superintendence, office expenses, salaries, interest, etc., remain very nearly the same whether the volume of traffic is large or small, but the relation or the percentage of the expenses to the earnings will diminish as the latter increase and vice versa.

For these reasons not much importance is assigned to what may be called the quantitative comparison of expenses of earnings, but it is true of railroads, as Thackeray jocularly expressed it of personal receipts and disbursements—income £2 9d.; outgo £2 10d.; result—misery; income £2 10d.; outgo £2 9d.; result—happiness. Of railroad companies it might be said—income \$3,000,000; expenses \$2,900,000; result—a dividend; income \$2,900,000; expenses \$3,000,000; result—a Receiver.

In the article in the *New York Times* which has been quoted it was said that the late Mr. Newell, President of the Lake Shore Railroad, had spent his life in improving that line, by straightening its curves, reducing its grades, improving its terminal facilities so as to make it more efficient as a dividend-earning enterprise. Mr. Newell was by profession and training a civil engineer and had an intimate knowledge of all the requirements which are essential in a great line of road to carry freight and passengers economically. He used this knowledge to the best advantage, but Mr. Newell was not a mechanical engineer and could not see as far through the furnace door of a locomotive as he could through an engineer's transit. All the indications seem to show that a mechanical engineer with the breadth of mind, knowledge, ability and level-headedness that Mr. Newell had could accomplish as much in the improvement of the efficiency of the rolling stock of a great railroad as he did in perfecting the line of the great road of which he was President.

This subject is again too big for the space we can now give to it, and so must be taken up again.

We heartily indorse the work which the *Railway Age* and other technical papers are carrying on for sound money in the present disturbed condition of business. It is worthy of the approbation of all who are interested in the cause of good government for all the people and opposed to measures that could only benefit the few at the expense of disaster and ruin to the many.

NOTES.

Mr. Shadrach A. Mustain, of Rincon, N. Mex., has patented a globular car. It consists of two globes for "transporting matter" attached to a suitable frame and having axles running in journal boxes. Each globe has two cylindrical surfaces, which form treads that run on the rails. The globes are hollow and the lading is carried inside of them. These would make excellent "rattlers" for cleaning castings, scrap iron, etc.

A test of the relative cost of coal and coke fuel was recently conducted for the directors of the gas and water works of Colmar, Germany. The tests were conducted on the boilers of the pumping plant of the town. The caloric values of the coke and coal were in the ratio of 1 to 0.89. The results showed that the cost of coke fuel was .92 times that of the coal required to generate the same amount of steam, or a saving of about eight per cent. in favor of the coke. The cost of the coal and coke per ton is not stated.

In the annual report of the New York, New Haven & Hartford Railroad for the year ending June 30, 1896, a reference is made to the company's experiment with the use of electricity as a motive power, and the statement is made that the result has been most gratifying and that it is now probable that a third rail may be laid at several points on the company's lines, after which short lines to centers of business and population would naturally follow. The company paid four dividends of 2 per cent. each last year, amounting to \$3,608,542.

The use of a pneumatic arrangement for whitewashing and painting is gradually spreading. It has reached England and is received with favor there. It is in this country used on several large systems to paint freight cars, sheds and buildings along the line. Painting of ships is another of the operations in which it ought to work well, and it has, we believe, been already employed in this manner. The arguments at first raised against the process, the chief one of which was that the paint would not stick, seem to have been swept aside.

Mr. L. L. Buck, Chief Engineer of the new East River bridge estimates that with no unexpected delays and with the needed money forthcoming, the bridge can be completed by Jan. 1, 1900, at an expenditure of \$7,510,000 on new contracts. Of this sum \$1,360,000 is required for tower foundations, \$1,640,000 for anchorages, \$372,000 for the steel towers and \$248,000 for their erection, \$750,000 for the cables and their erection, \$1,610,000 for the suspended superstructure and its erection, \$1,300,000 on approaches, and \$230,000 on flooring, painting, etc.

In a paper read before the Institute of Naval Architects, Col. N. Soliani, Director of Naval Construction in the Royal Italian Navy, recommended the adoption of compound marine boilers; that is, he proposes "compounding cylindrical boilers with water-tubes in such a way as to make them partake, to a certain extent, of the good features of the water-tube boilers, without detracting much from their own valuable characteristics." "Such a result," he says, may, in his opinion, "be achieved simply by doing away altogether with the water-spaces around the ordinary combustion chambers and substituting for them water-tubes, some of which could be properly arranged as a protecting screen in front of the tubes and tube-plates."

Three robbers tried to hold up the overland train on the Southern Pacific one night last month at a point between San Francisco and Sacramento. The engineer and fireman were covered by revolvers in the hands of two men, who crawled over the tender. The train was stopped by their orders and one of the would-be robbers left the cab to join an accomplice and aid in cutting out the express car, taking the fireman with him. The third robber guarded Engineer E. F. Ingles, but his attention was fixed on something else for a moment and the engineer promptly availed himself of his opportunity and shot him dead. The other two escaped. The fireman managed to elude them and got into the first coach as the train started again.

In a paper recently read before the Société Technique by Mr. Ravel, the author stated that acetylene kindles at about 900 degrees Fahr., while other inflammable gases fire at about 1,100 degrees Fahr. He said the temperature produced by the explosion of acetylene is over 7,200 degrees Fahr., while that of the oxy-hydrogen blowpipe is not more than about 5,400 degrees Fahr. This high temperature, together with the small amount of water vapor produced, makes the explosion of acetylene a very violent one. The flash produced is a blinding one, and it is very dangerous to bring a flame near a leakage of acetylene. Then the ease of lighting and the force of explosion promised to render acetylene very useful in gas engines. Tests were therefore made. The engine at first made a series of loud, sharp explosions, which threw the indicator lever out of gear. The lubrication had to be doubled, and the degree of cooling had a great deal more influence on the efficiency than when coal gas was used. The indicated work falls off with the proportion of acetylene. As the acetylene is increased the initial pressure rises, but the fall of pressure is immediate and the expansion is not kept up. As the acetylene approaches five per cent., the explosions become destructive, and there seems to be internal vibrations in the mixtures in the cylinder. Diminishing the compression, these vibrations are less and the work done is greater. The work done is then about 2.1 times as great as can be obtained from an equal volume of coal gas. Acetylene cannot be advantageously used in motors as at present constructed, for either it has to be too much diluted or else the explosion is too sharp.—*The Practical Engineer*.

An exchange says that at a recent congress of German engineers, at Cologne, Mr. Mausel presented a paper showing by that the use of petroleum water can be pumped in places where steam or hydraulic motors cannot be employed and gasworks do not exist. Gas motors are also adapted to the working methods of a gas plant, as the power can be utilized during the day time, when there is little or no demand for the gas as an illuminant. Germany was the first country to adopt gas as a motive power in pumping water. Gas motors, for this purpose, were installed at Dueven and Quedlinburg in 1884, at Coblenz and Rohlweil in 1886, at Fuerth and Peine in 1887, and at Münster and Karlsruhe in 1888. In some of these plants the gas motors are used with steam engines to supply any emergency demand. The last two plants in the following table show a material improvement in the utilization of gas. The motors used at Münster have an efficiency of 912,950 foot pounds per pound of fuel used. As an average there was used at this plant, in 10 hours, 170 pounds of coke and 400 pounds of anthracite coal for producing gas. A steam engine would have consumed three times this amount of fuel for the same work. At Rothenburg, where the motors are run with gasoline, the efficiency is 1,603,750 foot pounds per pound of gasoline. At Hohenstein, petroleum motors give an efficiency of 1,724,000 foot pounds per pound of petroleum. The following table shows the results obtained by gas motors in different waterworks, these works being arranged according to date of erection:

Towns.	Number of motors.	Horse power.	Foot-pound produced per cubic foot of gas used.
Dueren.....	2	40	46,555
Quedlinburg.....	2	15	49,258
Coblenz.....	3	40	51,071
Fuerth.....	2	40	51,071
Carlsruhe.....	2	50	53,047
Kotwig.....	1	15	47,313
Einbeck.....	2	10	48,234
Bingen.....	2	12	52,228
Goettingen.....	1	10	52,676
Melssen.....	2	50	70,460
Constanz.....	1	10	71,276

Superheating has for its sole purpose and result in the steam engine to-day the extinction or reduction of the internal thermal wastes of the engine, consequent upon the phenomenon known as initial or "cylinder condensation." Here it is extraordinarily effective, and a small quantity of heat expended in superheating the entering steam effects a comparatively large reduction in the expenditure of steam in the engine, each thermal unit thus employed saving several thermal units otherwise wasted. The process is one, mainly at least, of prevention rather than of cure of

that fault, and prevention is, as usual here, found to be vastly more effective than attempted cure.

Superheating is superior to any other known means of reduction of internal waste. Jacketing ordinarily suppresses but a fraction of that waste, and the multiple-cylinder engine has also its limitations, while superheating may not only extinguish it, but may also check wastes due to the resistance to flow of the denser wet steam through steam and exhaust ports, and may sensibly improve the vacuum attainable in the condenser, with corresponding reduction of back pressure, of the quantity of condensing water demanded, and of the load on the air pump. Superheating even a few degrees improves considerably the performance of the engine, and in the average case superheating 100 degrees Fahr. will entirely extinguish that waste. The hitherto unconquered obstructions to the use of superheated steam in the engine have been those resulting from destruction of packing and decomposition of lubricants, with consequent friction and "cutting" of the rubbing surfaces. The introduction of metallic packings and the high-test lubricants has now enormously reduced the difficulties of application of superheating. No trouble need now be found at the engine with sufficient superheating, under usual conditions of operation, to annihilate cylinder condensation. It seems not at all improbable that even this limit may be ere long safely, and perhaps even largely, overpassed, with resulting improvement of thermodynamic efficiency.—*Dr. R. H. Thurston, before the Am. Soc. of Mech. Eng.*

In a paper before the American Society of Mechanical Engineers, describing a new steam calorimeter in which the water is separated from the steam by a sudden change in direction of flow which causes the water by its inertia to be forced through the meshes of a cup placed in its pathway, the water being collected and measured, while the weight of the dry steam is derived by its flow through an opening that has been calibrated, for different pressures. Prof. R. C. Carpenter gives the following conclusions as guides to calorimetry practice: First, the steam ordinarily discharged from a boiler of proper proportion and in good working condition carries an exceedingly small percentage of water. Second, a certain amount of water will be carried along by the steam in the form of vapor or small drops; that this amount varies somewhat with the velocity, but probably does not exceed two or three per cent. by weight, and furthermore, a fair sample of such steam is usually obtained by any of the ordinary methods in use. Third, water is sometimes thrown from the boiler in large amounts, and in such a case it will usually remain distinct from the steam and will pass along the bottom of horizontal pipes in a stream of greater or less depth, and will flow if moving downward in a vertical pipe in irregular positions depending upon its velocity and various other considerations. Steam carrying water in this way when ascending in a vertical pipe will probably be irregularly charged, and samples drawn from time to time are likely to vary greatly. This condition can usually be considered an abnormal one and probably cannot be fairly sampled by any method. In case large amounts of water are thrown over, the quality of the steam cannot be even approximately obtained without the use of a steam separator for removing the excess of water. Fourth, steam, even in a very dry condition is likely to deposit a film of water on the inside of the pipe by condensation. This amount is rarely of sufficient importance to greatly affect the results, but if the calorimeter is so located as to draw this directly into the pipe it may show very wet steam when the contrary condition actually exists. The writer believes that samples for calorimetric determination should be drawn from a vertical pipe in which there is an ascending current of steam, and that the sample should be taken as uniformly as possible from all sections of the pipe, except that no steam should be drawn immediately adjacent the exterior portion of the pipe; and in such a case the results will indicate, if substantially uniform, in all cases not showing an excessive amount of moisture, the average quality of the steam within reasonable limits of errors of observation. Further, if the determinations obtained by the calorimeter in this position are irregular, or show large percentages of error, it may be reasonably

doubted that the sample of steam obtained is accurate. Fifth, a steam separator is always desirable to remove excess of water from the main steam pipe, in which case determinations should be taken after the steam has passed the separator. The writer, however, believes from his own experience that the use of the separator will not be found essential in one case out of twenty, for the reason that the water is very rarely thrown into the steam in larger quantities than the steam itself will take up and retain in a uniformly distributed condition.

Personals.

Mr. G. W. Dickinson, General Manager of the Western lines of the Northern Pacific, has resigned.

General James Jourdan has been appointed temporary Receiver of the Kings County Elevated road.

Mr. C. O. Skidmore, Master Mechanic of the New York, Philadelphia & Norfolk Railroad, has resigned.

Mr. Charles W. McMeekin has been appointed Chief Engineer of the Iowa Central, with office at Marshalltown, Ia.

Mr. F. F. Graf has been appointed Receiver of the Ohio Southern Railroad in place of Mr. J. R. Megrue, resigned.

Mr. W. H. McDoel, General Manager of the Louisville, New Albany & Chicago, has been appointed Receiver of that road.

Mr. C. W. F. Felt has been appointed Chief Engineer on the Gulf, Colorado & Santa Fe Railroad with headquarters at Galveston.

Mr. R. P. C. Sanderson, Division Superintendent of Motive Power of the Norfolk & Western, has resigned, and that position has been abolished.

Mr. A. G. Wright has been appointed Division Master Mechanic of the Chicago, St. Paul, Minneapolis & Omaha Railroad, with headquarters at Altoona, Wis.

Mr. J. H. McGill has been appointed Master Mechanic of the New Orleans and Northwestern and has charge of the locomotive and car departments and the water supply.

Mr. Henry Kistner has been appointed General Foreman of Motive Power and Car Department of the Monterey & Mexican Gulf Railroad, with headquarters at Monterey, Mex.

Mr. W. J. Miller has been appointed General Foreman of the Machinery Department of the Columbus, Sandusky & Hocking, at Columbus, O., to succeed Mr. P. T. Bancroft, resigned.

Mr. William Gibson, formerly Superintendent of the Cincinnati, Columbus and Sandusky divisions of the Big Four, has been appointed Assistant General Manager of the Baltimore & Ohio.

Mr. James Gaston has been appointed Master Car Builder of the Louisville, Evansville & St. Louis Railroad, with headquarters at Princeton, Ind. He takes the place of Mr. W. E. Looney, resigned.

Mr. W. H. Newman has accepted the position of Second Vice-President of the Great Northern and has resigned as Third Vice-President of the Chicago & Northwestern. His headquarters will be at St. Paul, Minn.

Mr. William Shinnott, formerly General Foreman of the Baltimore & Ohio shops at Philadelphia, has been appointed Division Master Mechanic of the Second and Third divisions, with headquarters at Cumberland, Md.

Mr. R. B. Burns, for years resident Engineer of the Atlantic & Pacific at Williams, Ariz., has been appointed Chief Engineer of that road, in charge of the maintenance of roadway and buildings, including service department.

Mr. J. G. Thomas, Assistant Superintendent of Motive Power and Equipment of the Central of New Jersey, with headquarters at Ashley, Pa., has been appointed Superintendent of Motive Power of the Lehigh & Susquehanna Division.

Mr. William H. Baldwin, Jr., has resigned the position of Second Vice-President of the Southern Railway to accept the Presidency of the Long Island Railroad, vice Mr. Austin Corbin, deceased. Mr. Baldwin will have his headquarters in New York.

Mr. W. G. Pearce, heretofore Assistant General Manager of the Northern Pacific, has been appointed Assistant General Superintendent of the reorganized road, with headquarters at Tacoma, Wash. Mr. Pearce will have jurisdiction over the lines west of Billings, Mont.

Mr. S. B. Hynes is General Manager of the Los Angeles Terminal Railway. Mr. William Wincup has resigned as Acting General Manager and Secretary, and Mr. F. K. Rule has been chosen Secretary. Mr. W. J. Cox has been appointed Assistant to the General Manager.

Mr. W. W. Finley, Second Vice-President of the Great Northern, has been elected Second Vice-President of the Southern, to succeed Mr. W. H. Baldwin, Jr. Mr. Finley was formerly Third Vice-President of the Southern, which position he resigned to return to the Great Northern, of which he had been previously General Traffic Manager.

Mr. W. H. Hudson, formerly Master Mechanic of the Southern Railway in Atlanta, has been appointed Master Mechanic at Salisbury, N. C. Mr. W. L. Tracy, formerly Master Mechanic at Birmingham, has been transferred to Atlanta, and Mr. W. A. Stone is transferred from Selma, Ala., to the position of Master Mechanic at Birmingham. Mr. Thos. M. Feeley takes charge at Selma.

Mr. E. H. McHenry, formerly Chief Engineer and lately one of the Receivers of the Northern Pacific, is now Chief Engineer of the reorganized road. Mr. W. L. Darling, who has been Chief Engineer since last April, has been appointed Division Engineer, with headquarters at St. Paul, Minn., in charge on lines east of Billings, Mont. C. S. Bihler is appointed Division Engineer, with headquarters at Tacoma, Wash., in charge on lines west of Billings, Mont.

J. F. Holloway.

Among a very large circle of friends and acquaintances the news of the death of the former President of the Society of Mechanical Engineers, which occurred at his home at Cuyahoga Falls, O., on September 1, was received with profound sorrow. His cheerful disposition, his hopefulness, his companionable nature, endeared him to all who had the privilege of his acquaintance. He was 71 years of age at the time of his death, which occurred after a brief illness, and was due to Bright's disease.

His business career was commenced in the works of the Cuyahoga Steam Furnace Company, in Cleveland. After his apprenticeship in this establishment he secured a place as Superintendent of a manufacturing company in Southern Illinois. He remained there until 1861, when he returned to Cleveland as Superintendent of the works in which he began his career. He occupied that position until 1872, when he was elected President of the company, which office he filled until the company went out of business in 1887. While occupying that position, it is said by a writer in the *Marine Review*, "By his industry, ingenuity and engineering skill, he assisted more than any man in laying the foundation of what is now regarded as the greatest merchant marine on any inland sea."

After the property of the Cuyahoga Company was sold, Mr. Holloway became associated with the Worthington Steam Pump Company, of New York, and remained there until about a year ago, when he became Consulting Engineer of the Snow Pump Company, of Buffalo, N. Y., which position he occupied at the time of his death.

He was one of the charter members of the American Society of Mechanical Engineers, and was elected President in 1884. He was also a member of the American Institute of Mining Engineers and of the Engineers' Club, of New York, and while a resident of Cleveland was a member of the Cleveland Civil Engineers' Society, of which he was at one time President. He often contributed papers to these associations, and took part in their discussions. He had the faculty of making what he wrote and said

interesting and easy of comprehension, which is not true of many of the contributors to engineering literature.

In the association of which he was a member he will be missed as long as those whose privilege it was to have his acquaintance will live. He always met them with a genial smile, and the sense of humor, which was one of his characteristics, attracted to him those into whose society he was thrown. Men who knew him best appreciated most the serious side of his character. With a long and varied experience in engineering, he had developed what may be called mechanical sagacity and a very sound judgment, which is of such great value in all engineering enterprises. In the words of the writer from whom we have already quoted, "One never failed to derive great benefit from his advice and pleasing suggestions, and yet the man of this disposition had the ability and capacity to manage successfully large engineering establishments, employing hundreds of men, whose confidence and esteem he enjoyed. He was held in the highest regard by his employees, and up to the time of his death had lost, among them still living, none of the good feeling that was due him from early years."

A wife, one son and one daughter survive him.

Equipment Notes.

The Baltimore & Ohio Railroad has received a large number of the 75 engines ordered several months ago.

The Northern Pacific is reported to have issued specifications for compound locomotives of special design.

The Chicago & Alton Railroad is building at its Bloomington shops 100 coal cars of 60,000 pounds capacity.

The Chicago, Rock Island & Pacific has given an order for 100 box cars to the Michigan-Peninsular Car Company.

The Baltimore & Ohio recently ordered a small electric locomotive for use in switching at the Baltimore terminals.

The Richmond Locomotive Works has orders for three 6-wheel connected engines for the Georgia & Alabama Railroad.

The Wabash is building two mail cars at its Toledo shops. The cars are 60 feet long and are equipped with Pintsch gas.

The Rogers Locomotive Works has been awarded a contract for three ten-wheel locomotives for the Keokuk & Western Railroad.

The Midland Terminal, of Colorado, has ordered two new engines and four new coaches for service between Cripple Creek and Gillett.

It is reported that the order for 100 refrigerator cars for Swift & Company, which was held up some time ago, will be let in the near future.

It is stated that the Pittsburgh Locomotive Works has orders for three 6-wheel connected engines from the China and Japan Trading Company.

It is reported that the Baldwin Locomotive Works has been awarded the contract for locomotives for the Tientsin & Peking Railway, which is a part of the Imperial Railway of China.

At the car shops of the Northern Pacific Railroad, South Tacoma, Wash., 120 new flat cars, of 70,000 pounds capacity, will be built in the next two months. The shops are also increasing the capacity of several hundred cars from 40,000 pounds to 50,000 pounds.

The Baltimore & Ohio Railroad put their new machine shops in Cumberland, Md., into operation last month. The shops cost \$340,000, including what is said to be the largest round house on the system.

The first shipment of motor cars for the New York and Brooklyn Bridge was received last month from the Pullman Car Company. The new cars are fitted with heavy motors, also a cable grip. The cars were run on their own trucks from Chicago. Each train over the bridge will have one of these motor cars attached for switching at the terminals.

The Fire-Retarding Qualities of Wired-Glass.

In a paper on the fire-retarding qualities of wired-glass, by C. A. Hexamer, C. E., in the Journal of the Franklin Institute for August, there is given the result of a test of wired-glass made at the request of the Mississippi Glass Company, and reported to the Philadelphia Fire Underwriters' Association. Briefly told the test is as follows: A brick test-house, about 8 by 4 feet, inside measurement, and nine feet high, was constructed in the yard of the Pennsylvania Iron Works. In one side of this structure a wired-glass window was fastened in a wooden frame, covered with lock-jointed tin. In another side, a Philadelphia standard fire-door was hung. The upper part of this door had a pane of wired-glass, 18 by 24 inches, set into a wooden metal-covered frame. The entire roof of the test-house was replaced by a skylight, the sash being constructed of wood, metal-covered; one side of this skylight being provided with three lights of $\frac{1}{2}$ -inch ordinary rough glass, the other side with three lights of wired-glass. The wired-glass used was $\frac{1}{2}$ inch thick, and was manufactured by the Mississippi Glass Company, of St. Louis. Iron grate bars were placed in the bottom of the test-house, and openings were left in the wall near the ground for free draught. The test house was filled for two-thirds of its height with wood treated with a liberal allowance of coal oil and resin. In a few minutes after the fire was started the ordinary rough glass in the skylight cracked and pieces began to fall into the fire. The wired-glass in the fire-door soon became red hot, also the three plates of wired-glass in skylight, but they retained their positions throughout the test. At the end of 30 minutes, water was thrown on the fire and also on the hot glass. After the fire was extinguished, the three plates of glass in the skylight were found to be cracked into countless pieces, but still adhering together, forming one sheet. The window light, which, as the result showed, was not properly secured to the frame, was found to be in same condition as skylight glass, except that a large crack had developed. The plate of glass in the standard fire-door was cracked, the same as the skylight; but having been well secured into the door frame, it did not give way. The action of the fire on the wooden metal-covered skylight and window frame showed conclusively that this class of construction is far superior to iron framing, no warping or giving way of any portion of the frames being noticed. The fire door in direct contact with the fire showed but little buckling on the inner side, and no signs of giving way. On removing the tin covering, it was found, however, that the inner layer of 1-inch boards was completely charred through, but that the second layer was only slightly damaged.

The conclusions to be drawn from the test appear to be as follows:

- (1) Wired-glass can safely be used in skylights, and in such situations will withstand a severe fire and will not give way when water is thrown on it. A wooden framing for skylight, covered with tin, all seams lock-jointed and concealed-nailed, is superior in fire-resisting quality to iron framing.
- (2) Wired-glass in wooden sash, covered with tin, all seams lock-jointed and concealed-nailed, can safely be used for windows toward an external exposure.
- (3) Wired-glass can safely be used in fire-doors to elevator shafts and stairway towers, where it is necessary to light said shafts.
- (4) In office buildings, hotels, etc., where it is undesirable to have elevator shafts entirely enclosed and dark, wired-glass permanently built into a brick or terra-cotta shaft, or arranged in a wood metal-covered frame, can safely be used.
- (5) Wired-glass plates, securely fastened in standard fire-shutters, can safely be used toward an external exposure. In this case, the fact that a possible fire in a building, all windows of which are protected by fire-shutters, can much more readily be detected from the outside through the wired-glass, is of importance.

Why an Electric Motor Revolves.*

The action of the current in producing rotation in an electric motor is quite simple.

The fundamental fact is the relation between an electric current and a magnet. If a piece of iron be surrounded by a coil through which current is passed, it becomes a magnet. It will attract iron, and the space surrounding it becomes magnetic. Iron filings will arrange themselves in the direction shown by the dotted lines in Fig. 1. One end of a magnet is a north pole and the other a south pole.

If a wire, such as *CD*, be moved past either pole of the magnet, there will be a tendency for current to flow in the wire either from *C* to *D* or from *D* to *C*, according to the character of the pole past which it is moved and to the direction of the movement. If the ends of the wire *CD* are joined by a conductor, so that there is a complete circuit, a current of electricity will flow through the circuit.

The reason why there is a tendency for an electric current to flow in the wire *CD* when it is moved in the vicinity of a magnet is not known. There are several theories, all more or less involved and depending upon pure assumptions as to the nature of an electric current. For all practical purposes it matters not what the reason is; the fact that current flows when there is an electric pressure in a closed circuit is the important thing, and it serves all useful pur-

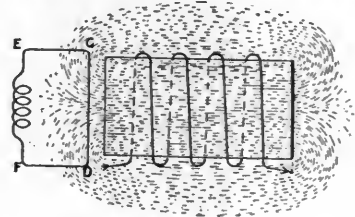


Fig. 1.

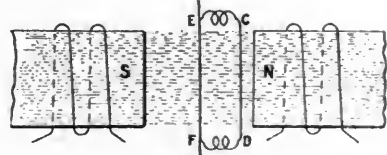


Fig. 2.

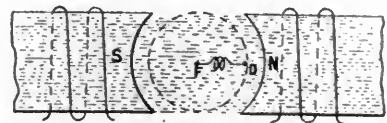


Fig. 3.

poses to know that current does flow, and that its direction and amount are always the same under similar circumstances.

The intensity of the electric pressure, or electro-motive force, depends upon the velocity of revolution of the wires and upon the strength of the magnets, and the quantity of current depends upon the electro-motive force and upon the amount of the resistance in the circuit. Other things being equal, the current through a long small wire, or greater resistance, will be less than through a short thick one, or a less resistance.

Two electro-magnets are shown in Fig. 2, in which the north pole of one magnet is near the south pole of the other, and the magnetic field between the two lies in approximately straight lines between the two magnets, as indicated by the dotted lines. If the wire *CD* be moved across this field and its ends be joined, as by the circuit *CEFD*, a current will flow in this circuit. The wire *CD* may be made to revolve around the wire *EF*, passing in front of one pole and then in front of the other pole, as in Fig. 3. The current in the circuit will pass in one direction when the wire is passing one pole, and in the other direction when it is passing the other

* From a pamphlet or catalogue of electric locomotives, issued by the Baldwin Locomotive Works and the Westinghouse Electric & Manufacturing Company, and written by Mr. D. L. Barnes.

pole. The connection between this elementary arrangement and the dynamo is easily recognized. In the dynamo a magnetic field is produced by electro-magnets called "field poles," and a considerable number of wires similar to the wire *CD* are placed upon an armature so that they revolve in front of the poles. Each individual wire produces current first in one direction and then in another direction, as explained above; but if there be many wires, there will always be the same number in front of the positive pole and the same number in front of the negative pole, so that the total or resultant action is practically uniform and may be made to produce a continuous current. Such a machine is the common dynamo or motor.

A dynamo transforms mechanical into electrical energy, and a motor transforms electrical into mechanical energy. The two operations are reversible and may be effected in the same machine; a dynamo may be used as a motor or a motor may become a dynamo. A machine is a motor when it is driven by a current of electricity, and it is a dynamo when it is driven by mechanical power and produces an electric current. A simple form of electric machine is shown in Fig. 4, which is the general form of the electric motor. In this there are two projections of steel, *H* and *G*, which are made electro-magnets by the current going through the wires wound around them from any source of electricity, such as a battery at *I* and *J*. These magnets have poles facing toward a drum, *K*, revolving on a shaft. The poles *G* and *H* are called the "salient" poles; the other two the "consequent" poles. The magnetic flow or field is shown by the dotted lines. On the periphery of the drum are arranged wires in the slots shown. As this drum is revolved, there will be a tendency for electricity to flow in the wires. In order to get a current of electricity from these wires it is necessary to make a complete circuit. A each of the wires in the slots passes

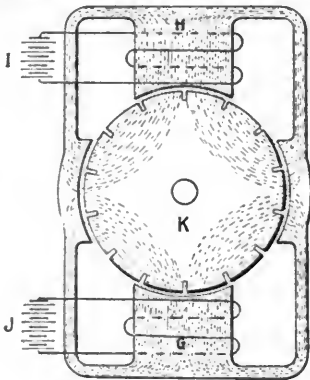


Fig. 4.

in front of a pole, a pressure or electro-motive force will be generated, and its direction will depend upon whether the pole is a north or a south pole.

The pressure or electro-motive force generated in the wires moving in front of the positive or north field poles will be in one direction, while those in front of the negative or south poles will be in the opposite direction. Therefore, if two such wires be connected together at one end of the armature, the free terminals of the wire at the other end of the armature will have the sum of the electro-motive forces generated in the two wires. The wires so connected can be considered as a turn of a single wire, instead of two separate wires, and this turn may be connected in series with other turns, so that the resulting electro-motive force is the sum of that in all the turns and all the wires so connected. It is customary to connect the coils of an armature so that the electro-motive force given is that obtained from half the coils in series. The other half of the coils is connected in parallel with the first half, so that the currents flowing in the two halves will unite to give a current in the external circuit equal to twice the current in the two armature circuits or paths.

It is evident that, as the armature revolves, wires which were in front of the positive pole will pass in front of the negative pole, and that in order to maintain the electro-motive force it will be necessary to change the connections from the armature winding to the external circuit in such a way that all the wires between the two points of connection will have their electro-motive forces in the

proper direction. The connection to the armature must therefore be made not a definite point in the armature itself, but at a definite point with reference to the field magnets, so that all the wires between two points or contacts shall always sustain the same relation to the field magnets.

For this purpose a device known as a "commutator" is provided. The commutator is made of a number of segments, as shown at *A*, in Fig. 5, which are connected to the armature winding. On the commutator are sliding contacts, or brushes, which bear on the segments and are joined to an external circuit, making a continuous path through which current may flow. As the commutator revolves the different segments come under the brushes, so that the relative position of the armature wires between the brushes is dependent on the position of the brushes. The armature wires which connect the brushes are those sustaining the desired definite position to the field magnets, so that the currents from the armature at all times flow properly into the external circuit, although indi-

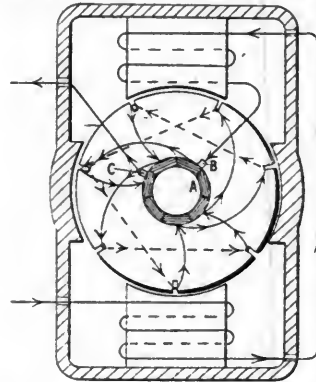


Fig. 5.

vidual armature wires carry currents first in one direction and then in the other direction, depending on the character of the pole in front of which they may be moving.

On two-pole machines there are two brush-holders, each containing one or more brushes. On the four-pole machine there may be either two or four brush-holders, and on a six-pole machine, either two, four or six brush-holders.

A single path of the current through the commutator and armature winding is shown by the arrows on Fig. 5. The brushes *B* and *C* are placed on the top side of the commutator to make them more accessible, and this gives a peculiar but simple armature winding.

For the sake of simplicity, the batteries *I* and *J* of Fig. 4 are not used on common forms of generators or motors, but the current that flows from the armature through the commutator is made to flow through the electro-magnets either in whole or in part. If all of the armature current flows around the electro-magnets or fields of the machine, it is a "series" machine; if only a part of the current is used in this way, it is a "shunt" machine, that is, some of the current is "shunted" through the fields. Sometimes both the shunt and series windings are used, and in that case the machine is called a "compound wound" machine. Such a machine has a large wire through which the main current passes, and a fine wire through which the shunted current flows. Fig. 5 shows how the commutator and the fields are connected, and how the current flows from the wires in the armature through the commutator in a series machine.

If the current delivered by a dynamo does not flow in the desired direction, it can be reversed by shifting the wires in the binding posts or by throwing a switch. If the motor does not revolve in the desired direction, it can be made to do so by reversing the connections to the armature or field-coils; so that, without knowing which way a current of electricity is to be generated, any practical man can make a motor revolve in a proper direction by simply changing the connections.

It is natural that a machine which gives out electric energy when driven by an external power will, when electric energy is delivered to it, reverse its action and give out mechanical power and do work. This is not a logical reason why a motor revolves under the influence of an electric current, but it is a natural inference which assists in comprehending the fact.



Switching Engine Burning Crude Petroleum.—Built by Brooks Locomotive Works

At the banquet several excellent addresses were made. President Walitt, speaking on "Our Club," said, in part:

We cannot as a club look back on long years of work, the organization being to-night but 12 years and five months old. We cannot boast the largest membership, for our newly born sister club at St. Louis has for the time being outnumbered us. But the Western Railway Club can with pride look back over 12 years' work and point to some of the most valuable papers, from both a technical and practical standpoint, that have ever emanated from any similar organization. The Western Railway Club has been peculiarly fortunate in its membership. It is with great satisfaction that we are able to point to the fact that we have among our active members a large number of men fortified by a thorough technical training which has been supplemented by years of practical work, enabling them to bring to the deliberations of our club the sound reasoning and good judgment for which our work has for many years been noted. As we look with pride on the past we should not stop satisfied.

Colonel H. G. Prout, of the *Railroad Gazette*, responding to "The Press," alluded to the railroad profession and then questioned if he was exactly right in using the term "profession." He believed, however, that the professional spirit was on the increase. He said, in part:

I like to think that the professional spirit is growing fast among railroad officers. Whether or not railroading is a profession: whether or not it ever can be a profession, is a small matter and the vital thing is that railroad officers should have the professional spirit. We must look to this spirit to save the railroads from the ignorant and corrupt subordinate. We must look to it to save the railroads from the brigands in high places seeking only to make their own fortunes. Perhaps we must look to it to save the railroads from confiscation by Socialists and Populists, and, in fact, by honest voters who would come to be classed with either. How the professional spirit will do all this I need not point out. It will administer the properties for the interest of their owners and not for the profit of salaried officers. But, in the long run the interest of the owners is the interest of the public, and thus we find the probable solution of much that is most troublesome in what is called the railroad problem.

Other speakers were President Lemont, of Purdue University. Mr. J. H. P. Hughart, Second Vice-President, and General Manager of the Grand Rapids & Indiana Railroad; Mr. M. C. Markham, Assistant Traffic Manager of the Illinois Central; Mr. F. W. Morse, of the Grand Trunk; Mr. Geo. H. Heafford, Mr. H. C. Buhoup and Mr. E. B. Leigh. A straw vote for the presidential candidates resulted thus: McKinley, 39; Palmer, 4; Bryan, 0.

Locomotive for Burning Petroleum Fuel.—Built by the Brooks' Locomotive Works.

In the accompanying illustration we show an interesting engine recently built by the Brooks' Locomotive Works, Dunkirk, New York. It is a six-wheeled switching locomotive for the Congress Gold Company, of Congress, Ariz., and is equipped for the use of crude petroleum as fuel. The details of the oil burning specialties are not fully covered by patents and therefore we are not at liberty to publish them at present, but we expect to place them before our readers in the near future. The engine has cylinders 17 inches by 24 inches, driving wheels 51 inches in diameter, a boiler 56 inches in diameter, a firebox 78 inches by 32 inches, a driving wheel base of 11 feet, and a total

wheel base of 46 feet 6 inches, including tender. The total weight of the engine alone in working order is 112,000 pounds. The boiler pressure is 180 pounds. The tank capacity is 3,600 gallons of water and the oil tank will hold about five tons of petroleum. The engine is fitted with Jerome metallic packing, Nathan injectors and cylinder lubricator, McKee-Fulla steel tired wheels under tender, National brake beams, Cooke bell ringers, Westinghouse brake and train signal, also the Le Chatelier water brake, Janney couplers, Tilden wrecking frogs and the Nathan fire extinguisher.

Electric and Compressed-Air Locomotives for the Manhattan Elevated.

The electric locomotive which the Manhattan Elevated Railway will try upon the Thirty-fourth street branch of its lines is now complete. It has the same arrangement of running gear as the present steam locomotives on the road, there being two pairs of drivers and a four-wheeled truck.

There is a motor on each driving axle. The motors will take current from a third rail, but the locomotive carries a large number of storage batteries which will be charged from the third rail when the current required for the motor is below a certain amount and which will automatically furnish current to the motor, in addition to what the latter receives from the third rail when the demands on the motor are heavy. In this way the batteries take care of the "peak" of the loads.

The company is also about to try a compressed-air motor of the Hardie type. This is now building at Rome, N. Y. We understand that both the compressed-air and electric locomotives will weigh slightly more than the present steam locomotives.

The British Admiralty have ordered the stern torpedo tubes to be taken out of all ships of the *Royal Sovereign* class, and these vessels will now carry only the submerged tubes. There are two very substantial reasons for this course. Experiments have been made which have demonstrated the possibility of hitting the whiskers of a torpedo by means of quick-firing guns while the weapon is in the tube and thus hoisting the engineer with his own petard. Then (says the *Naval and Military Record*) it has been found on the China station that where the stern tube is reasonably near the water-line the seas in rough weather fill the tube, and, if the torpedo is there, collapse the balance chamber. The trials of the *Eclipse* were especially directed to elucidate this point, but though no accident occurred in that cruiser, owing to her tube being well out of the water, an immunity from accident is not guaranteed to ships less favorably constructed. Hence the necessity that has arisen for removing the tubes.—*Exchange*

The New Battle-Ships.

The bids for three new battle-ships authorized by Congress at its last session were opened in Washington on Sept. 14. The bids were as follows:

John H. Dialogue & Sons, Camden, N. J., one battle-ship for \$2,661,000.

Bath Iron Works, Bath, Me., one battle-ship for \$2,680,000.

Newport News Shipbuilding and Dry Dock Company, Newport News, Va., one battle-ship for \$2,595,000.

Union Iron Works of San Francisco, one battle-ship for \$2,674,950.

William Cramps & Sons' Ship and Engine Company, Philadelphia, one battle-ship for \$2,650,000; two battle-ships for \$2,650,000 each.

As a difference of 4 per cent. in favor of Pacific coast builders has always been allowed on account of the cost of transporting materials across the continent and to offset the voyage of the Atlantic-built ships to the Pacific for duty on that ocean, this must be deducted for the purpose of comparison, thus bringing the San Francisco bid down to \$2,568,952, or within \$3,952 of the lowest bid, and considerably under that of the Cramps.

The result of the bidding is that the Newport News Company, the Union Iron Works and Wm. Cramps & Sons Company will each build one ship.

These battle-ships are to be the most powerful yet constructed for our navy. In size, displacement and general characteristics the new vessels will not be much different from the *Indiana*. The total length on the water line will be 368 feet, or only a few feet longer than the *Indiana* class, while their extreme beam will be 72 feet 2½ inches, which makes them the widest battle-ships in the navy. Their freeboard, 19½ feet, will also be a little above that of battle-ships of their class, and as the guns will be several feet above the decks, their fire is expected to be as efficient as the batteries of the *Kearsarge* and *Kentucky* type, with their great superposed turrets mounting 8-inch guns above the 13-inch rifles. The freeboard aft is 6 feet below its extreme height forward. The normal displacement is given as 11,525 tons, but it will approximate 12,000 tons when the ships are in actual service and ready for fighting. The displacement is about the same as that of the *Kearsarge* type.

To propel these vessels 10,000 horse power will be required to give them an estimated speed of 16 knots in a seaway. In this respect the vessels are supposed to be one knot better than the *Indiana* type, whose plans only called for 15 knots an hour on a four hours' run. The normal coal supply will be 300 tons, and the maximum bunker capacity 1,200, the latter supply enabling the big ships to have a wide radius of action at a 10-knot speed.

In the batteries of these ships the ordnance officers have endeavored to present the largest quantity of heavy ordnance carried by any ships of their class afloat. The arrangement of the guns, especially those of the secondary battery, is the best for raking fire yet designed, and, while there has been a departure in the assignment of ordnance from that followed in the *Indiana* class in doing away with 8-inch guns in order to increase the number of lighter guns, it is not believed that the power of the ship as a fighter will suffer. The main battery will consist of four 13-inch rifles mounted in two turrets, fore and aft, and fourteen 6-inch rapid-fire guns arranged in broadside. The secondary battery comprises sixteen 6 pounders, four 1-pounders, four machine guns and one field gun.

The engines are of the triple-expansion type and they drive twin screws. The cylinders will be 34, 50 and 78 inches in diameter, and have a stroke of 48 inches. To generate the steam necessary to develop the required horse power there will be eight large boilers with a total grate surface of 635 square feet. The working pressure will be 180 pounds. The armor belt will be of Harveyized steel 16½ inches thick and 7½ feet deep.

Statistics recently published at Munich show that there are in operation in Central Europe, 15,644 gas engines aggregating 52,694 horse power.

The Spontaneous Ignition of Coal.

The following interesting extract is taken from *Kuhlows German Trade Review*, and it is interesting to notice that Professor Dr. Medem traces spontaneous ignition to the oxidation of iron pyrites, and as no coal is entirely free from this sulphide of iron, the cases the doctor brings under notice become all the more interesting.

Professor Dr. Medem, in the course of a treatise on the spontaneous combustion of hay and coal, gives the following account of the causes this phenomenon and methods that have been proposed for its prevention and suppression.

The simplest form of spontaneous ignition is exhibited by dry spongy platinum, and is due to the absorption and condensation of oxygen in the pores of the metal. When exposed to a current of hydrogen gas, chemical combination immediately sets in, raising the temperature sufficiently to ignite the stream of hydrogen.

In the case of charcoal, a pyrophoric tendency is only manifested when some of the volatile hydrocarbons have been left behind in the distillation process and enter into combination with absorbed oxygen. If, however, such charcoal be freely exposed to air, the external portions speedily lose this property, owing to the pores becoming saturated with air, but it will regain its pyrophoric character if powdered so that the internal layers are enabled to absorb oxygen. As the process of chemical combination always goes on in the interior of a heap, the best way to arrest it is to spread the charcoal out, since attempts at ventilation by blowing or drawing air through the mass will only result in increasing the combustion. Every time the charcoal is broken up the danger of ignition will recur, down to the time it is ground to powder, but powdered charcoal once "killed" by exposure to air never regains its pyrophoric properties.

Hard coals, brown coals and the like are subject to two dangers, explosion and ignition, each having a separate cause. Explosion is due to the liberation of fire-damp following on a decrease in atmospheric pressure, whereas ignition results from the oxidation of the iron pyrites contained in the coal, when exposed to the action of oxygen and moisture. The danger is the greater the finer the state of division of the coal, and coal stacked above ground is particularly liable. Attempts made to reduce the danger by ventilating the stacks have failed in this case also, on account of the increased amount of oxygen thereby introduced into the interior of the mass, and accordingly the coal is stacked as tightly as possible in order to exclude air. Strangely enough, the practice of ventilating the coal bunkers of ships has not been altogether abandoned, notwithstanding Liebig's impressive warning given as far back as 1836, and neglect in this particular has frequently led to lamentable fatalities. Since 1865 no less than 97 coal laden vessels have been destroyed and the lives of some 2,000 seamen sacrificed through spontaneous ignition of the cargo.—*Colliery Engineer*.

Central Railroad Club.

At the September meeting of the Central Railroad Club the Committee on Car Roofs made a report, also the Committee on Planished Iron vs. Plain Sheet Iron or Steel for Locomotive Boiler Jackets. Part of the latter report is as follows:

We find that the difference between the first cost in material of planished iron and plain sheet iron or steel, for the jacket of an engine, to vary considerably, running from \$21.61 to \$37, in favor of the plain sheet-iron or steel jacket.

We also find practically the same difference between the total cost of labor and material of the planished iron and plain sheet iron or steel jacket, as applied to an engine, the difference running from \$20.14 to \$37, in favor of the plain sheet-iron or steel jacket.

The life of a planished iron jacket when placed on a good boiler covering, and with proper care taken of it, would be from eight to ten years, and during this time, when the gloss is worn off, or the condition of the jacket should warrant it, it can be then painted, and be maintained at the same cost as the sheet-iron or steel jacket.

We have no information or facts showing the life of a sheet iron or steel jacket.

The cost of maintenance is a difficult question to answer. The planished iron jacket is cared for by the fireman, and he must use some material to keep it clean and protect the jacket from injury from water and drippings from roundhouse, etc., and we are strongly of the opinion that the cost of material to take care of the planished iron jacket will keep a sheet-iron or steel jacket painted. We find from the replies received that to keep the sheet-iron or steel jacket in good condition, they will require two coats of paint a year, at an annual cost of about \$5.

This report and the one on car roofs (which we have not yet received) will be discussed at the next meeting. The report on tool rooms presented at the May meeting was passed without discussion. The new interchange rules were discussed at some length from which it appears that rulings of the Arbitration Committee on certain matters is required at once. There is a conflict of opinion in regard to the interpretation of the rule covering "wrong repairs." A resolution was passed as follows:

"When cars are interchanged having M. C. B. repair cards attached, and also having improper repairs not covered by M. C. B. defect cards, that the repair card be sufficient authority to pass the car to the owning road; and, further, that cars in interchange found with improper repairs and no M. C. B. repair card or defect card attached, that the policy now outlined at Buffalo is to take a record of such wrong repairs when it is possible to distinguish them and that record shall be all the evidence necessary and that all the action necessary at any interchange point to pass that car home to the owning road."

Section 48 of Rule 3 will be interpreted by the members as though the word "simultaneously" had been printed before the last two paragraphs.

President Bronner announced the following subjects and committees for the meeting in November:

"What is the best plan to bring about the adoption of M. C. B. standards by railroads?" Committee: A. M. Waitt, G. W. West, R. S. Miller, James Macbeth, William McWood, John S. Lentz.

"Apprentice boys in railroad shops." Committee: S. Higgins, M. L. Flynn, E. D. Nelson, W. G. Taber, N. Lavery, John Mackenzie.

H. H. Perkins, Local Freight Agent of the New York Central, is also to read a paper on this topic: "Shall the cubic capacity of ordinary box cars be increased, and if so, what should be the maximum limit?"

American Society of Irrigation Engineers.

The annual meeting of this society will be held in Denver, Dec. 11 and 12, closing in time to reach Phoenix for the opening of the International Irrigation Congress on the 15th of that month. At the meeting State Engineer Mead, of Wyoming, will present a paper on "Land Laws for Arid Regions." "Pipes vs. Flumes" will be another principal subject. These papers will be printed and distributed in advance for discussion, and a circular will also shortly be issued giving full particulars of the programme for the meeting. J. S. Titcomb, Jacobson Building, Denver, is secretary.

THE MOST ADVANTAGEOUS DIMENSIONS FOR LOCOMOTIVE EXHAUST PIPES AND SMOKESTACKS.*

BY INSPECTOR TROSKE.

(Continued from Page 234.)

We thus see without any further explanation that with the smaller nozzle distances the shallowest (.31-inch) bridge is the better: at greater distances the second and at the greatest distances the deepest or 1.89-inch bridge is the best. The conclusion to be drawn from this is that with the .31-inch bridge the angle of deflection for the portion of the steam jet above the nozzle, and consequently its sectional area, is greater than that of those varying from .63 inches to 1.89 inches in depth. A larger sectional area of the jet must, with a shorter nozzle distance, force the vacuum more strongly than one of a smaller area would do, but it also fills the smallest sectional area of the stack more quickly, and consequently will begin to drop away from the full value of the vacuum earlier than a jet of smaller sectional area. This explains the earlier attainment of the highest point and also the earlier dropping away of the curve as compared with that of the bridges .94 inch and 1.89 inches deep.

If, in the graphical representation under II. of Plate VII., those nozzle distances fall short of giving the better results, especially in connection with the shallow bridge and the funnel-shaped stacks than they do for the waist stacks, the reason is to be found in the fact of the bad connection of the steam and the entrained air, as was explained at the close of Section IV.

Finally an effort was made to determine whether it were better to have the top of the bridge flush with the top of the nozzle or allow it to project above the same. For this purpose the two nozzles shown in Fig. 62 were used. Their diameters were 5.12 inches and 4.94 inches respectively, and while they had the same free opening, the bridges were set at different heights. The results are given in Plate VII. under III. We see that a somewhat better result was obtained with the flush bridge, which is due to the greater surface of the jet of steam issuing from the nozzle 5.12 inches in diameter.

VIII.—FORM AND DIVERGENCE OF THE STEAM JET.

In order to accurately determine the effect of the bridge upon the shape of the steam jet and thus draw a correct conclusion regarding the cause of the increase of draft as well as the lessening of the same by a contraction of the stack, an investigation was made to ascertain what might be the form and size of the steam jet issuing from the nozzle of the apparatus. It was accomplished by using the rings that had been employed for changing the nozzle positions and setting them on top of one another, the lowest first and so on up to the highest, and then putting the lowest on this, and at each change allowing steam to blow out under the same pressure as in

the smokestack experiments. This showed that the lower portion of the jet for a length of about 19.68 inches is in the form of a smooth truncated cone, which from measurements taken near the nozzle opening has a somewhat sharper flare than at greater distances, as shown by the last column of table XXV., and which further on appears to become first weaker and then rougher and more broken up on the outer surface.

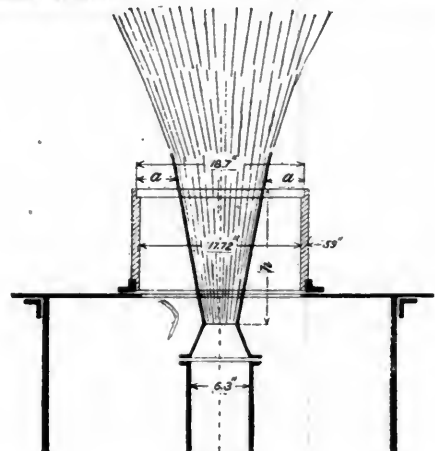


FIG. 63.

The distances, indicated by a in Fig. 63 from the edge of the ring to the steam jet, were now measured at four points that were opposite each other, and this was done for the different heights of rings up to 25.79 inches above the nozzle opening, and from it the diameter of the steam jet was calculated at four different heights. The last was found to be in exactly the same condition within the ring as in the smokestack experiments. These measurements were taken for all fine nozzle diameters, and it was found that the diameter of the jet increases with the increasing diameter of the nozzle opening as that diameter itself increases. The jet on leaving the nozzle has the same diameter as the latter; at least no difference could be detected.

The shape of the jet undergoes almost no change at different steam pressures; with the higher pressure the lower smooth portion is merely lengthened a trifle, which means that the broken surface of the outside appears at a somewhat greater distance from the nozzle opening. The relation of the stack to the different nozzle pressures is dependent upon this very fact, as we have already explained in Section II.

The five foregoing measurements of the steam jet are grouped together in Table XXIV., from which the averages for the jet diameters as given in Table XXV. are obtained.

It will be seen from these tables that exact measurements amid that loud and almost intolerable noise of a large steam jet was not practicable, since it was not possible to bring the rule in direct contact with the rapid current of exhaust steam. This explains the difference between the bracketed figures and the actual maximum measurements of Table XXIV.

According to Table XXV. the diameter of the section of the jet for all five nozzles increases in an arithmetical ratio with them, so that, at the same heights, the section is increased by the same coefficient. At a distance of 25.79 inches from the nozzle this increase in all five cases amounts to 10.67 inches, from which we see that the average flare of the jet is

$$1 : \frac{25.79}{10.67} = 1 : 2.41,$$

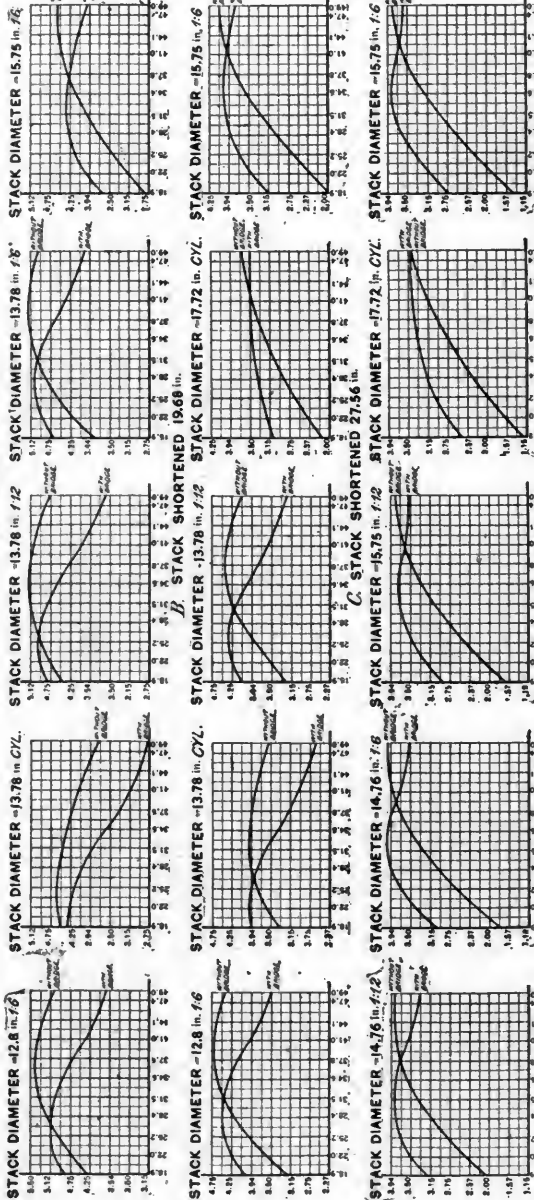
which means that the conical sides of a continuous current of steam are inclined to a vertical at an angle of 1 in 4.8, as shown in Fig. 64.

Figure 65 shows the form of a jet as it issues from a nozzle 4.72 inches in diameter. If this is drawn full size and the outlines a and b plotted, it will be seen that these latter vary only very slightly from the actual outlines. The sharpest relative flare naturally occurs in the lower portion of the jet, which is shown by the last column of Table XXV. to be 1 in 2.2 instead of 1 in 2.4. At a height of 15.75 inches the flare of the outer surface becomes 1 in 2.34, and at 19.68 inches it is 1 in 2.39. Now, since in the general

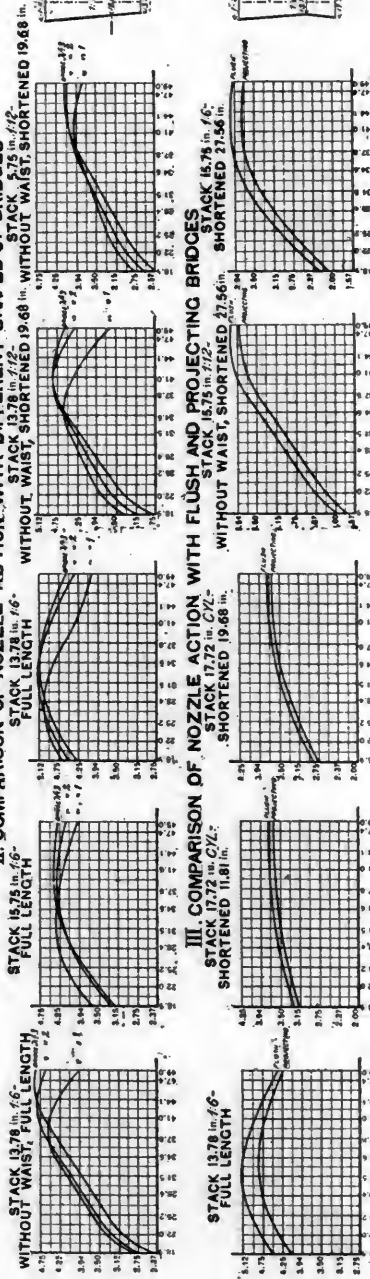
* Paper read before the German Society of Mechanical Engineers, and published in *Glaser's Annalen für Gewerbe und Bauwesen*.

I. COMPARISON OF NOZZLE ACTION WITH AND WITHOUT A BRIDGE

A. FULL LENGTH STACK



II. COMPARISON OF NOZZLE ACTION WITH DIFFERENT SHAPES OF BRIDGES



III. COMPARISON OF NOZZLE ACTION WITH FLUSH AND PROJECTING BRIDGES

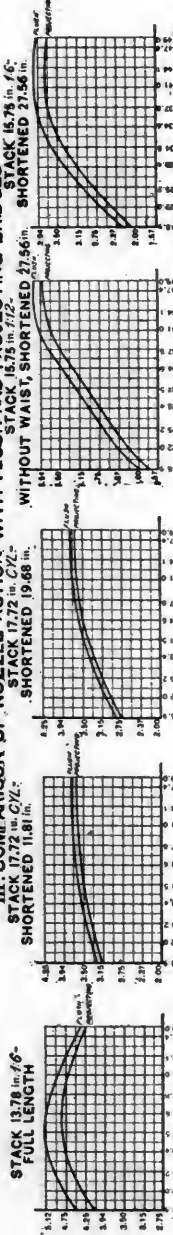



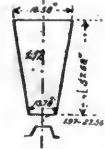
PLATE VII.—DETAIL DIAGRAM OF THE HANOVER SMOKE STACK AND EXHAUST NOZZLE EXPERIMENTS.

Figures. —1. The abscissas, which indicate the nozzle distances, for stacks that have no waister and for the cylindrical stacks 17.72 inches in diameter, are measured from a zero point 17.52 inches above the smallest cross section which is at the bottom of the stack proper, and 18.9 inches above the highest position of the nozzle.
2. In the experiments tabulated under 1., the nozzle without a bridge had a diameter of 4.74 inches, while that of the one with a bridge was 5.15 inches. The width of the bridge was .63 inches and the depth .31 inches. Both nozzles had the same free opening.


TABLE XXIII.
1.—STACK 13.78 INCHES DIAMETER, $\frac{1}{2}$ FLARE, NO WAIST.

Distance of nozzle from bottom of stack, inches.	Length of Stack.								Remarks.
	Full length (4 ft. 9.68 in.).		Shortened 11.81 in. (3 ft. 9.87 in.).		Shortened 19.68 in. (3 ft. 2 in.).		Shortened 27.56 in. (2 ft. 6.12 in.).		
	Water column, inches.	Per cent.	Water column, inches.	Per cent.	Water column, inches.	Per cent.	Water column, inches.	Per cent.	
1.97	+.67	28.8	+.86	44.9	+.91	58.5	1.10	90.3	
3.94	.73	28.0	.91	40.7	.99	50.5	1.19	79.6	
7.87	.69	22.7	.87	32.3	.94	40.0	1.12	57.5	
11.81	.63	18.6	.81	26.4	.87	31.0	1.01	43.1	
15.75	.57	15.1	.75	21.6	.79	24.3	.94	33.1	
19.68	.39	9.4	.57	14.8	.59	16.2	.77	23.0	
23.62	.00	0.0	+.12	2.7	+.15	3.6	+.29	7.7	
27.56	-.55	(0 @ 24.57) -.43	(0 @ 24.73) -.39	(0 @ 25.71) -.21	

2.—STACK, 13.78 INCHES DIAMETER, $1\frac{1}{2}$ FLARE (WITHOUT WAIST).

Distance of nozzle from bottom of stack, in.	Length of Stack.								Remarks.
	Full length (4 ft. 9.68 in.).		Shortened 11.81 in. (3 ft. 9.87 in.).		Shortened 19.68 in. (3 ft. 2 in.).		Shortened 27.56 in. (2 ft. 6.12 in.).		
	Water column, in.	Per cent.	Water column, in.	Per cent.	Water column, in.	Per cent.	Water column, in.	Per cent.	
1.97	.45	12.7	+.69	22.8	+.94	36.6	1.09	56.7	
3.94	.39	10.1	.60	17.5	.85	28.6	1.05	46.1	
7.87	.29	6.9	.52	13.8	.75	22.0	.98	35.5	
11.81	.24	5.2	.41	10.1	.63	16.9	.88	27.8	
15.75	.18	4.1	.33	7.6	.50	12.3	.75	21.0	
19.68	+.03	0	.10	2.1	.17	3.8	.38	9.5	
	(0@20)		(0@20.79)		(0@21.26)		(0@22.64)		
23.62	-.31	.....	-.29	.....	-.28	.....	-.12	.....
27.56	-.71	.....	-.75	.....	-.75	.....	-.61	.....

3.—STACK 15.75 INCHES DIAMETER, $\frac{1}{2}$ FLARE (WITHOUT WAIST).

Distance of nozzle from bottom of stack, inches.	Length of Stack.								Remarks.
	Full length (4 feet 9.68 inches).		Shortened 11.81 inches (3 feet 9.87 inches).		Shortened 19.68 inches (3 feet 2 inches).		Shortened 27.56 inches (2 feet 6.12 inches).		
	Water column inches.	Per cent.	Water column inches.	Per cent.	Water column inches.	Per cent.	Water column inches.	Per cent.	
1.97	.52	17.7	.80	33.2	1.00	53.1	1.11	88.2	
3.94	.48	15.5	.75	28.8	.98	46.7	1.10	72.7	
7.87	.44	12.8	.65	22.3	.89	36.0	1.06	55.1	
11.81	.36	10.2	.56	17.8	.78	28.2	.98	43.1	
15.75	.29	7.8	.47	14.8	.66	21.4	.92	34.7	
19.68	.24	6	.37	10.2	.54	16.2	.79	26.1	
23.62	.08		.19	4.6	.31	8.6	.51	15.3	
27.56	(6 @ 25.2) .15		(0 @ 25.77) .06		(0 @ 26.19) .03		(0 @ 26.92) .20	5.4	

4.—STACK 15.75 INCHES DIAMETER, $\frac{1}{2}$ FLARE (WITH WAIST).


Distance of nozzle from bottom of stack, inches.	Length of stack.								Remarks.
	Full length (4 feet 9.68 inches).		Shortened 11.81 inches (3 feet 9.5 inches).		Shortened 19.68 inches (3 feet 2 inches).		Shortened 27.56 inches (2 feet 6.12 inches).		
	Water column, inches.	Per cent.	Water column, inches.	Per cent.	Water Column, inches.	Per cent.	Water Column, inches.	Per cent.	
1.97	.86	29.4	—	—	1.19	58.7	1.30	84.6	
3.94	.89	27.5	—	—	1.18	52.6	1.27	71.6	
7.87	.76	21.6	—	—	1.06	59.4	1.18	52.6	
11.81	.53	13.8	—	—	.88	28.1	1.04	39.0	
15.75	.26	6.2	—	—	.60	17.3	.79	25.6	
19.68	.0	—	—	—	.28	7.6	.43	13.0	
23.62	— .21	—	—	—	(0@24.25) + .04	—	(0@25.67) + .14	3.7	
27.56	— .41	—	—	—	— .16	—	— .09	—	

TABLE XXIV.


Distance of the head section from the nozzle.	Amount of the distance a with a nozzle diameter of—					Remarks.
	3.94 inches.	4.33 inches.	4.72 inches.	5.12 inches.	5.51 inches.	
	Inches.	Inches.	Inches.	Inches.	Inches.	
5.51	6.10 to 6.30 (6.14)	6.02 (5.95)	5.71 (5.75)	5.51 (5.55)	5.32 to 5.57 (5.35)	 The bracketed figures form the basis of Table XXV. The other are working dimensions.
10.16	5.12 to 5.32 (5.15)	4.94 (4.95)	4.61 to 4.74 (4.78)	4.53 (4.57)	4.33 (4.37)	
14.16	4.34 to 4.55 (4.33)	4.13 to 4.33 (4.13)	3.74 to 3.94 (3.94)	3.54 to 3.74 (3.74)	3.62 (3.54)	
18.03	3.54 to 3.74 (3.62)	3.35 to 3.54 (3.13)	3.15 to 3.35 (3.25)	3.15 to 3.27 (3.03)	2.76 (2.53)	
25.75	2.17 to 2.36 (2.03)	1.77 (1.83)	1.37 (1.53)	1.38 to 1.57 (1.46)	1.18 to 1.38 (1.26)	

TABLE XXV.

Distance of the measured section from the nozzle.	Diameter of the steam jet with a nozzle diameter of					Flare of the steam jet.
	3.94 in.	4.33 in.	4.72 in.	5.12 in.	5.51 in.	
Inches.	Inches	Inches	Inches	Inches	Inches	
5.51	6.41	6.81	7.21	7.60	7.99	1 in. @2.22
10.15	8.39	8.78	9.17	9.57	9.96	1 " @2.28
14.17	10.04	10.43	10.83	11.18	11.61	1 " @2.32
18.03	11.46	11.80	12.24	12.64	13.03	1 " @2.39
25.78	14.61	15.00	15.39	15.79	16.18	1 " @2.41
Total increase in diameter.	10.67	10.67	10.67	10.67	10.67	

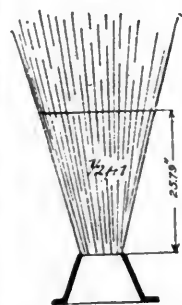


Fig. 64.

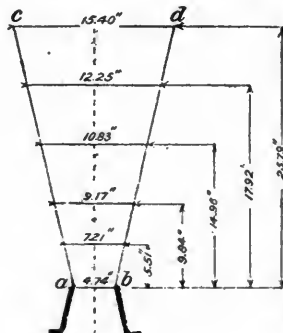


Fig. 65.

practice on modern standard gage locomotives, it is scarcely possible to put the nozzle at a shorter distance than 15.75 inches, we may consider that, for all practical purposes, the flare of the exhaust is 1 in 2.4.

This is then readily applicable to all nozzle distances up to 27.56 inches.

Beyond this latter dimension the calculation would no longer be quite as accurate, because the current of steam has its outer surface very much broken up and so fills up a somewhat greater sectional area.

This knowledge of the shape of the jet renders it possible to determine the efficiency of any chosen nozzle distance from the smallest section of the stack, as we have already shown in what proceeds. If we base our calculations upon a flare of 1 in 2.4, the corresponding distance at which the smallest cross-section of the stack is just filled by a continuous jet of steam is shown in the following table for the several nozzle diameters:

Smallest diameter of stack.	Nozzle diameter.	Distance from nozzle at which the stack is filled.
11.81 inches.	3.94 inches.	1 foot 6.90 inches.
12.80 "	4.33 "	1 " 8.32 "
13.78 "	4.72 "	1 " 10.21 "
14.76 "	5.12 "	1 " 11.62 "
15.75 "	5.51 "	2 " 1.51 "

If we also make a comparison of this with the lines of the diagram of Plate I, we will see that the that the abscissas given in the last column are approximately the same for the given nozzle diameters and turn slightly to the horizontal, while for the shorter abscissas they are almost straight. Had the experiments been made with waist-shaped stacks with nozzle distances of 18.9 inches and a diameter of 3.94 inches it would doubtless have shown that the lines would have been very similar in their lower portions to those of the funnel-shaped stacks, which means that they would have been approximately straight. This explains the reason why there is a sharp curvature of the lines of the diagrams and their final dropping down toward the axis of the abscissas at the greater nozzle distances.

IX.—INFLUENCE OF THE BRIDGE ON THE FORM OF THE STEAM JET.

In the same manner as we described in VIII, the different sections of a stream of steam issuing from a nozzle with a bridge were measured. The nozzle had a diameter of 5.12 inches, the bridge was .63 wide and .31 inches deep. We found, in the first place, that the

circular cross-section of the jet had been changed into an ellipse by the bridge, into which the longer axis lay at right angles to the bridge.

Fig. 66 shows such a section of the jet by the cross-hatched lines for a height of 18.07 inches. The outer circle shows the ring used for the measuring; the dimensions given are those from which the axis of the ellipse were located.

It is thus seen how the wedge-shaped surface of the bridge causes the steam to make a sharp deflection at right angles to its length, while in the direction of its axis there is a smaller variation from the circular section that is quite noticeable, as is shown in Table XXVI.

TABLE XXVI.

Distance of the measured section from the nozzle opening.	Major Axis.			Minor Axis.		
	Distance a.	Diameter of steam jet.	Flare of the side of the cone.	Distance a.	Diameter of steam jet.	Flare of the side of the cone.
Inches.	Inches.	Inches.		Inches.	Inches.	
10.16	2.76 to 2.95 = (2.85)	5.12	1 in 1.3	4.53 to 4.72 = (4.65)	9.25	1 in 2.36
18.03	.39 = (39)	17.92	1 " 1.4	2.95 to 3.15 = (3.03)	12.61	1 " 2.1
25.79	-.79 to .98 = (.98)	20.67	1 " 1.65	1.57 to 1.77 = (1.65)	15.32	1 " 2.5

With this form of bridge we may consider that the average flare of the current of steam in the direction of the longer axis is from 1 in 1.5 to 1 in 1.6 and that in the direction of the shorter it ranges at about 1 in 2.45 as shown by Fig. 67.

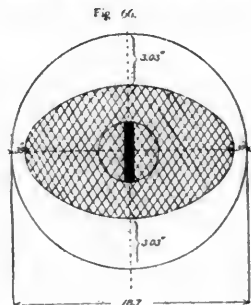


Fig. 66.

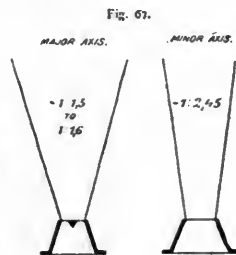


Fig. 67.



Fig. 68.

In consequence of this elliptical section the external surface of such a jet of steam has a greater area and fills the section of the stack much earlier, that is to say at a lesser distance from the nozzle opening, than would be the case with a steam jet of the same size but of circular section. Hence by an application of the bridge to a nozzle having the same free opening we have:

1. A better indraft of air or products of combustion on account of the greater surface area of the jet.
2. And also a more effective height of stack, because of the fact that the section is filled earlier on account of the elliptical form of the jet.

It may also be mentioned that with a nozzle distance of 25.79 inches the jet of steam struck against the upper edge of the ring on a line with the major axis, so that the measurement *a* became negative and should be reckoned at from .79 to .93.

Another result of the earlier filling of the section of the stack is shown in the fact that the apparatus began to throw water earlier, and that upon the locomotive spark-throwing also appeared earlier.

This shows us that the bridge is not applicable to great nozzle distance, and in general with stacks like those used on the experimental apparatus there is a throwing of water as indicated in table XXI.

(To be continued.)

New Publications.

POOR'S MANUAL OF THE RAILROADS OF THE UNITED STATES, 1896. H. V. & H. W. Poor, 44 Broad street, New York. 1,609 pages, 6 inches by 9 inches. Price, \$7.50.

The publishers of this well known manual in 1896 consolidated with it "Poor's Handbook of Investment Securities." As a result the volume before us includes state and municipal investments, industrial securities, etc. It has 258 more pages than the 1895 edition, and contains statements of 2,040 steam railroad companies, 1,208 street railroads, 143 industrial corporations, and 1,008 state, county, city, town, etc., debts—in all 4,399 corporations, aggregating \$16,475,000,000. The labor and expense of such a work can in a measure be appreciated from these figures. Notwithstanding the wider scope of this accurate work its price remains as heretofore.

REPORT OF THE PROCEEDINGS OF THE THIRTEENTH ANNUAL CONVENTION OF THE MASTER CAR BUILDERS' ASSOCIATION, 1896. Pages, 6 inches by 9 inches. (John W. Cloud, Secretary, Chicago Ill.)

This volume needs no extensive notice by us. It appears in its usual form, is well bound, and is much larger than any previous report of the association. It contains much valuable information, as is always the case with the proceedings of this society.

BAKER'S RAILWAY MAGAZINE. Monthly. Published by Geo. H. Baker, Metropolitan Building, New York. \$3.00 per year.

The first number of this new magazine appeared last month and a copy is before us. It contains a number of interesting articles by men well known in railroad circles, and is good reading. If future issues can be maintained on the same plane as this first one the publication ought to, and, we hope, will succeed. As an inducement to prospective subscribers an art supplement (reproduced on a small scale in the first number) is for the present given with each subscription. The central figure is a woman, who ought to improve her form or else wear more clothes.

THE PRACTICAL ENGINEERS' POCKET BOOK AND DIARY, 1896. Edited by William H. Fowler. Technical Publishing Company, Limited, Manchester, England. 404 pages. 3½ by 5½ inches. 1s. 6d.

A "Pocket Book" or a dictionary always fill a reviewer's mind with despair as it is almost impossible to give an idea of their characteristics in a notice as brief as a review must necessarily be. In the present instance a nice enumeration of the subjects treated would occupy more room than can be given to the book. It begins with 19 pages of mensuration and tables, etc., which are common to all publications of this class. The next 42 pages are devoted to steam boilers in which a great variety of information is given relating to their construction and operation. This and the succeeding 79 pages devoted to the steam engine are the strong features of the book. After these chapters there are articles on the indicator, transmission of power, gas and oil engines, hydraulic and lifting machinery, friction, cutting tools, gearing, notes on heat, nickel steel, aluminum pipes, bolts and nuts, strength and weight of various materials. A feature in the latter part of the book which indicates the advance which has been made in certain directions is notes on electrical engines by S. T. Harrison, which occupies 50 pages. Notes on patents and patent law and a blank diary complete the book.

REPORT OF THE PROCEEDINGS OF THE TWENTY-NINTH ANNUAL CONVENTION OF THE AMERICAN RAILWAY MASTER MECHANICS' ASSOCIATION, 1896. 365 pages, 6 inches by 9 inches. (John W. Cloud, Secretary, Chicago, Ill.)

The contents of this volume are already familiar to our readers through the report of the proceedings given in our July issue. The members will be gratified at the improvement in the binding of this volume as compared with preceding ones. It is in cloth instead of paper covers and is exceedingly neat in appearance. The plain black, relieved only by the title in gilt on the binding, is a relief from the gaily-colored designs with which each volume has been decorated in recent years, and is more in keeping with the dignity of the association.

THE UNIVERSAL DIRECTORY OF RAILWAY OFFICIALS, 1896. Compiled from official sources. By S. R. Blundstone, Editor of the Railway Engineer. Price, 10 shillings. The Directory Publishing Company, Ltd., 8 Catherine St., Strand, W. C., London. 374 pages, 5½ inches by 8½ inches.

This book, less than one inch thick, contains information which cannot be obtained from any other single volume published and is what its name indicates—a universal directory. Of course it does not list the very small roads in this or other countries, but

its selection of roads for publication has apparently been carefully made, and few persons would have occasion to write to officials outside of their own countries whose address cannot be found in this work. A few omissions might be noted, one being that not an operating, purchasing or mechanical official of the Southern Railway is listed, but on the whole it is an excellent compilation.

Books Received.

BULLETIN OF THE DEPARTMENT OF LABOR, No. 5, July, 1896. Edited by Carroll D. Wright, Commissioner. Washington; Government Printing Office. 1896. 122 pages.

IRON MAKING IN ALABAMA. By William Battle Phillips, Ph. D., Consulting Chemist Tennessee Coal, Iron & Railroad Company, Birmingham, Ala. Issued by the Alabama Geological Survey, Eugene Allen Smith, Ph. D., Director. 1896.

Trade Catalogues.

[In 1891 the Master Car-Builders' Association, for convenience in the filing and preservation of pamphlets, catalogues, specifications, etc., adopted a number of standard sizes. These are given here in order that the size of the publications of this kind, which are noticed under this head, may be compared with the standards, and it may be known whether they conform thereto.]

It seems very desirable that all trade catalogues published should conform to the standard sizes adopted by the Master Car-Builders' Association, and therefore in noticing catalogues hereafter it will be stated in brackets whether they are or are not of one of the standard sizes.]

CATALOGUE "B." Rue Manufacturing Company, 116 North Ninth Street, Philadelphia, Pa., U. S. A. Injectors, 1896. 12 pages, 7 inches by 9 inches. (Standard size.)

This company manufactures the well-known "little giant," "fixed nozzle" and "unique" injectors, Rue's patent boiler-washing and testing apparatus, ejectors, and other jet apparatus, steam valves and boiler checks, and this catalogue is descriptive of these devices. These are illustrated and described, directions given for their application and use, and tables of size, capacity and price afford the information the purchaser desires. Catalogue "B" is a railway edition, and those desiring information about stationary injectors should write for catalogue "A."

ELECTRIC LOCOMOTIVES—Baldwin Locomotive Works, Burnham Williams & Co., Philadelphia, and the Westinghouse Electric and Manufacturing Company, Pittsburgh, Pa. By David Leonard Barnes, Consulting Engineer. 123 pages, 6 inches by 9 inches. (Standard size.)

While largely descriptive of the electric locomotives that these companies have built jointly or are prepared to build, the book also contains much valuable information on electrical apparatus, presented in a way that makes it easily understood by practical mechanically trained men who have but little knowledge of electricity. Electric locomotives for passenger, freight, switching, elevated and suburban and mine traffic are illustrated, as are also the trucks, motors and controllers for them. Diagrams of horsepower, torque, speed and efficiency of motors are given, a form of specification, an outline of data required for a preliminary estimate of the cost of electrical equipment, a glossary of electrical terms and a chapter explaining "why an electric motor revolves" complete the work. In another part of this issue will be found a part of the last named chapter. The engravings and press work are of the best.

RECENT ENGINEERING WORK. Ford & Bacon, Engineers. 28 pages. 9¼ by 13¼ inches.

This is a handsome publication containing illustrations and descriptions of engineering work recently completed by this firm of engineers. Included in it are articles on the system of the Orleans Railroad, of New Orleans, La., the Bergen County Traction Company, in Bergen County, N. J., and an instructive article on steam piping for electric railway power plants. The illustrations show up many valuable details. This firm takes entire charge of all engineering details of construction of electric railways, including all civil, mechanical and electrical engineering connected with the work, preliminary surveys and estimates, etc. They have offices in the Mail and Express Building, New York; Philadelphia Bank Building, Philadelphia, and the Morris Building, New Orleans.

IMPERIAL GERMAN DRAWING INSTRUMENTS. Thos. Atterder & Sons, Philadelphia. 16 pages. 3¼ by 6 inches.

This is a current little pocket catalogue describes German drawing instruments which this firm has for sale. The engravings are good and the printing excellent.



Fig. 1.—Lidgerwood Cableway at Hilo Hawaii.



Fig. 2.—Landing Freight from Steamer, Hilo, Hawaii.



Fig. 3.—Lidgerwood Cableway, Hilo, Hawaii—Tail Tower, Warehouse Wharf and Derricks.

A Lidgerwood Cableway at Hilo, Hawaiian Islands.

We show in the three engravings printed herewith an interesting and somewhat unusual installation of the Lidgerwood cableway at Hilo, Hawaiian Islands, where it is used by the Onomea Sugar Company for transporting sugar, lumber and general freights.

The coast at this point is a rough one, and it is a matter of much difficulty to convey material to and from vessels and the wharf, this being done by using small boats, as shown. The sugar or other freight is hoisted from the small boats by a number of derricks placed upon the wharf and afterward carried by the cableway up the hill to a point at the head tower. Or, if it is to be shipped, the cableway takes the material down to the landing, and from there it is transported to the vessel ready to receive it by the small boats. The cableway is of the latest improved Lidgerwood pattern with main cable two inches in diameter. The head tower is 60 feet high; tail tower 50 feet.

The average load handled is two tons. In Fig. 3 the cableway is seen transporting a load of 4,500 pounds of barley.

This cableway was furnished the Onomea Sugar Company through the Pacific Coast agents of the Lidgerwood Manufacturing Company, Messrs. Parke & Lacey Company, of San Francisco, Cal. It was set up by the native workmen at Hilo, without other help from the builders than general instructions.

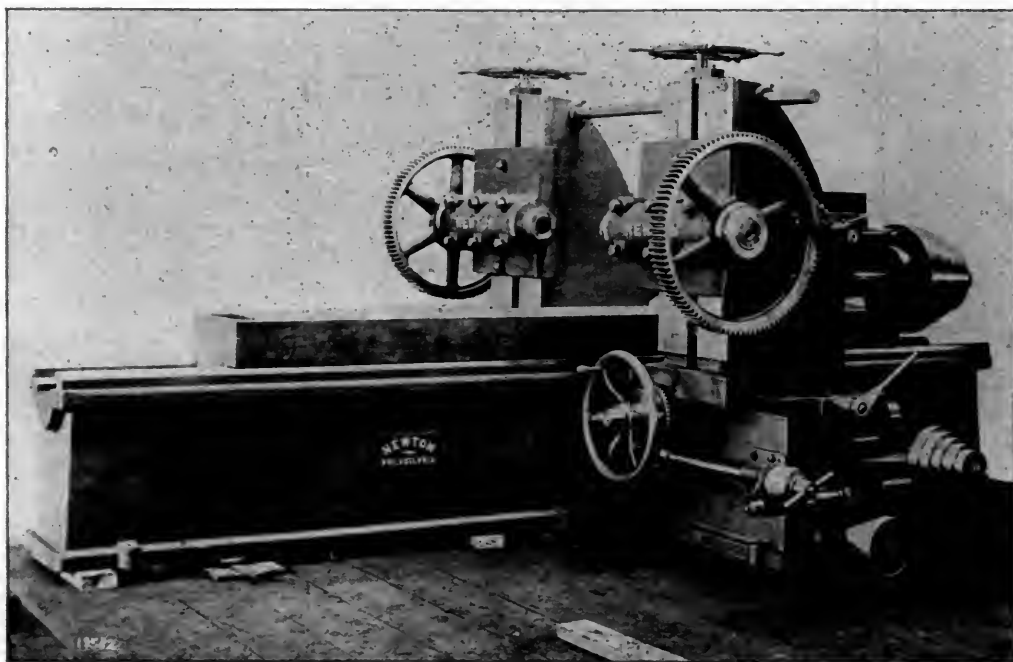
Of its working the Onomea Company say, in a recent letter to the Lidgerwood Manufacturing Company: "You will be glad to hear that the cableway is working perfectly in every way." Where convenience, dispatch and economy in operation are considered, one of the best devices for hoisting and conveying material of all sorts is the Lidgerwood cableway.

Relative Cost of Iron and Copper as Conductors.

The accompanying table, given by Mr. J. R. Allen in *The Technician*, shows the relative cost of copper in cents per pound as compared with wrought iron, Bessemer steel and cast iron in dollars per ton. The comparison is made for conductors having equivalent carrying capacity. In using Bessemer steel rails for conductors it is possible to use those that are winding and imperfect. Such rails may be purchased at a greatly reduced price.

Cost of copper, in cents per pound.	Cost of equivalent wrought iron conductor, in dollars per ton.	Cost of equivalent Bessemer steel conductor, in dollars per ton.	Cost of equivalent cast iron conductor, in dollars per ton.
7.	19.25	18.10	14.50
7.5	20.75	19.50	15.50
8.	21.50	20.30	16.75
8.5	23.75	22.25	17.75
9.	25.00	23.50	19.00
9.5	26.50	25.00	20.00
10.	28.00	26.25	21.00
10.5	29.25	27.50	22.00
11.	30.75	29.00	23.00
11.5	32.25	30.25	24.25
12.	33.50	31.75	25.25
12.5	35.00	33.00	26.25
13.	36.50	34.50	27.25
13.5	38.00	35.75	28.50

Consider the saving that can be made by the use of Bessemer rails, assuming the rails to cost \$25 per ton, as compared with copper at 11 cents per pound. Let the current to be transmitted be



A Heavy Milling Machine for Locomotive Work—Built by the Newton Machine Tool Works, Philadelphia.

1,000 amperes at 500 volts and the distance it is to be transmitted be three miles with 5 per cent. drop in voltage.

Cost of copper conductors.....	\$39,000
Cost of Bessemer steel conductors.....	23,711

Difference.....	\$5,289
Deducting \$400 per mile for bonding.....	1,200

Total saving.....	\$4,089
Saving per mile.....	1,363

The first use of steel rails as conductors was on the intramural road at the World's Fair. The Metropolitan and Lake street Elevated Roads, of Chicago, have adopted steel rails as conductors, as has also the New York, New Haven & Hartford Railroad, on its new extension of the electrical equipment on the Nantasket Beach line, though in the last mentioned case the rails are of special form

The Gas Exposition in New York.

During the two weeks beginning January 25, 1897, there will be held in Madison Square Garden, New York, an exposition that should attract much interest and liberal patronage. It is to be a gas exposition held under the management of the Gas Industries Company, and is the first affair of the kind attempted in this country. In a number of European countries gas exhibitions are a regular feature of each year's entertainments, and at the present Berlin exhibition the gas building is said to be one of the most pleasing and at the same time a very interesting exhibit.

The exposition in New York will be managed by a board of directors, assisted by an executive committee. It is comprised of men familiar to the commercial and financial world, whose names are a guarantee that this project will be a complete success in every particular. The executive committee will come in more direct touch with exhibitors. As appointed that body consists of the following gentlemen:

E. C. Brown, Chairman; W. H. Bradley, Chief Engineer Consolidated Gas Company of New York; Col. W. E. Barrows, President Welsbach Light Company; Walton Clark, General Superintendent United Gas Improvement Company, Philadelphia; Emerson McMillin, President The Gas Companies of St. Louis, Mil-

waukee, Columbus (O.) and Grand Rapids (Mich.). The offices for the present will be located at 280 Broadway, Rooms 237-8, where applications for exhibition spaces can be made or information of any character relating to the exposition be obtained.

The interest in the methods of gas manufacture, the qualities of gas and the appliances utilizing it for various purposes is great enough to ensure the success of the project from a mechanical standpoint, particularly under the excellent management of the present board of directors, and it should also be possible to make the exhibits equally interesting and instructive to the general public.

A Heavy Milling Machine for Locomotive Work.

The tendency toward a heavier construction of milling machines for railroad shop use is strikingly illustrated by the tool built for the new Russian-American Locomotive Works of Nijni Novgorod, Russia, by the Newton Machine Tool Works, of Philadelphia, and illustrated in the accompanying engraving. This machine is called by the builders their "No. 6 duplex milling machine," and is an advanced type of this line of tools. These duplex machines were designed in 1885, and intended principally for locomotive work. The first built were the No. 4, which weighed about 10,000 pounds. The requirements of milling machines increased and the company placed on the market a larger size, which was classed as the No. 5. When Mr. Dixon, the Chief Engineer of the Sormovo Company (of which the new locomotive works is a part) was investigating the merits of milling machines, he decided upon one of still heavier construction, namely the No. 6. This can be used for milling and completing drivingboxes, milling two sides at one time, milling out for the shoes and wedges and milling the inside to admit the cellar. These are the heaviest requirements of the machine. On rod work the machine can be used for panelling by removing the face cutters and using two ordinary panelling cutters on the end of each spindle, two rods can be panelled at one time. With flat rods, an ordinary heavy cutter can be used, one head then acting as a live head and the other as a tail support for the arbor. This machine is of an exceptionally heavy design. Its total weight, with a carriage to mill 11 feet long, is 35,000 pounds. The spindles of the machine

are 6 inches in diameter, the carriage 23 inches wide and 12 feet long to mill 11 feet in length. The spindles can be raised 26 inches from centre to carriage and will admit work 45 inches wide between the facing heads. The spindles are driven with large spur gearing; the driving pinion shaft, has a phosphor bronze triple lead worm wheel which is driven by a Harveyized steel worm, with the thrust collars of phosphor bronze and Harveyized steel. With this arrangement, an enormous power is given to the spindles and the machine is capable of handling the heaviest classes of work. The feed is suitable for the modern requirements of milling and has a range of from $\frac{1}{4}$ inch to 10 inches per minute. The carriage of the machine is fed with a rack and spiral pinion, and has a quick power movement in both directions. One valuable feature of this machine is the heavy tie rod which clamps both uprights after they are set and keeps them from springing apart on heavy cuts. Some remarkably heavy work has recently been done on one of these machines in milling large bronze driving boxes. The company has also recently patented a method for keeping cutters cool, which adds greatly to the amount of work that can be done by these machines. The spindle carrying the cutter is made hollow, and the cutter perforated with numerous small openings by which oil or water can be delivered directly on the cutting edges. The water passing through the interior of the cutter helps to keep it cool, and the quantity of it that can be delivered exactly where it will do the most good has an equally beneficial effect. On a recent test a cut $\frac{3}{4}$ inch deep was taken off a piece of forged steel 7 inches wide with a feed of 10 inches per minute, and the cutter remained cool and sharp.

Oil Tube Drills.

The accompanying cut illustrates the style of oil tube drills which are manufactured by the Cleveland Twist Drill Company, Cleveland O. In boring deep holes it is necessary that lubrication of the cutting and bearing surfaces shall be satisfactory, inasmuch as the close packing of the chips will not in such cases admit of proper lubrication by gravitation, and it is necessary to provide other means for forcing the oil down on to the cutting lips. In the drill shown this is accomplished by means of grooves cut just deep enough to admit of enclosing a small brass tube, making a smooth surface as ordinarily provided for in twist drills.

The tubes terminate at the lower ends in openings discharging



Oil Tube Drills.—Cleveland Twist Drill Co.

the oil directly at the cutting edges of the drill. The upper ends of the tubes project from the shank of the drill and through these the oil is inserted. With a high speed and heavy feed, drills beat at the points, as it is impossible to force in a lubricant, and it was to overcome this objectionable feature that these tube drills were placed on the market.

There may be several ways of conveying the oil through the tubes; the one recommended is as follows: The tubes are cut flush with the shank end, then a collet placed on the shank which fits the turret. An oil pipe is connected with the center of the turret and carried down to a chamber connecting with the butt end of the drill. The oil is forced through on to the point with considerable force, and assists in sending the chips up the flutes, and at the same time keeps the cutting lips perfectly cool. Collets are made for various-sized drills, and as the outside diameters of the collets fit the turret, a drill can be changed in a few seconds.

The company has already furnished a great many of these tools to turret lathe and bicycle manufacturers, and they are giving excellent satisfaction.

The La Villa Heaters.

The A. A. Griffing Iron Company has brought out a double line of heaters called the La Villa. We say "double line," since they make them two ways, with ornamental side-plate and base-plate and without. The capacity is the same in both, but of course the price is less for the latter. The La Villa heaters savor of stove construction. They are ornamental and portable and may even be had with removable ashpan. There are ten sizes made for steam

and a like number for water, making twenty in all. The company claims a very great amount of direct fire surface, since the entire fire pot is deeply corrugated. In the La Villa the fire has to travel three times the entire length of the heater before reaching the smoke pipe. It is very easily cleaned, for when the front and rear clean-out doors are opened every square inch of the heater is visible and accessible for a thorough cleaning. This is a very important factor in any heater. If a heater can be easily cleaned the chances are that it will be frequently cleaned, and if kept clean the economy of fuel is very marked. The best heater made if coated with the deposits of combustion, which are non-conductive in their nature, is very seriously handicapped.

The La Villa, having a rocking and dumping grate, will burn successfully soft or hard coal, coke or wood, is easily set up, comes practically in three parts, viz.:—base plate, ashpit section with grates already set in, and heater proper. It is not designed for heating large buildings, but for the thousands of small buildings such as cottages, small railway stations, etc., that are heated with steam or water every year and at a surprisingly low cost. Additional information can be obtained by writing to A. A. Griffing Iron Company, 66-68 Centre street, New York; 177-179 Fort Hill square, Boston; 702 Arch street, Philadelphia, or the works at Jersey City, N. J., mentioning this paper.

A patent was issued to the Crane Company, of Chicago, on July 23, for its Safety Valve for the Baker Heater.

The Niles Tool Works at Hamilton, O., will soon ship a large consignment of planers and boring machines to Italy and Austria.

The Vulcan Iron Works, of Chicago, has an order for new steam turning machinery, for the Grassy Point Draw of the St. Paul & Duluth Railroad, at Duluth.

The city of Chicago will receive bids until November 14 for six pumps with a capacity of 20,000,000 gallons in 24 hours. These are to be placed in a new pumping station to supply water to the north-western section of the city.

The Morgan Engineering Company of Alliance, O., shipped last month 200 tons of machinery to Russia for the new locomotive works there. There were two steam hammers, a hydraulic crane and a hydraulic flanging press.

The Edward P. Allis Company, Milwaukee, Wis., has orders for two cross compound vertical direct-acting blowing engines for export to Austria. They are said to be the largest blowing engines ever built and their weight is about 275 tons each.

The firm of Hoopes & Townsend, of Philadelphia, manufacturers of bolts, nuts, washers, rivets, etc., is particularly fortunate in having its large plant kept pretty busy during such times as these. Two of the shops are running 10 hours per day, and the others seven hours.

At a meeting of the stockholders of the Westinghouse Machine Company held last month, it was decided to increase the capital stock of the concern from \$750,000 to \$1,500,000, the new capital to be used principally in the development and manufacturing of gas engines.

The Laidlaw-Dunn-Gordon Company, Cincinnati, O., has painted on the roof of its factory, which is 665 feet long, and located close to the Cincinnati Hamilton & Dayton tracks, a sign in letters of gold, 13 feet high, the wording of which is "McKinley, Hobart and Sound Money."

The Rand Drill Company has recently received an order from the Michigan Central Railroad Company for three air compressors for its shops in Detroit and Jackson, Mich., and St. Thomas, Can.; also an order for two air compressors for the Missouri Car and Foundry Company, St. Louis.

Two rock crushers, with a daily capacity of 200 tons each, has just been shipped by the Gates Iron Works, Chicago, to the Coolgardie gold fields of West Australia. The Gates Iron Works also has an order for one of their largest crushers, capacity two tons per minute, for the Basalt Actien Gesellschaft of Kolen, Germany.

Messrs. Fitzbush & Spencer, who have represented the Standard Steel Works and the Baldwin Locomotive Works in Chicago, have given up the agencies. The two companies have leased a suite of rooms on the twelfth floor of the Monadnock Building, Chicago, and their offices there will be in charge of Mr. Charles Riddell.

The Brightman Furnace Company, Cleveland, has sold to the Union Pacific Railway Company three of its largest stokers. Contracts now on hand include the following Cleveland firms: Jewish Orphan Asylum (fourth order), the Cleveland Steam Fitting Company, and the B. F. Goodrich Company, Akron, O., fourth order, comprising four large stokers.

The annual meeting of the stockholders of the Westinghouse Air Brake Company of Pittsburgh was held last month. The report showed that the past year had been the most prosperous in the history of the company. The gross business was \$5,947,600.57 and the profit \$2,607,936.44. The old officers and directors were unanimously re-elected. The board re-elected all of the officers.

The Wells Street bridge, Chicago, was opened to the public on the 18th, after being closed since July 3. The structure has been entirely rebuilt by the Northwestern Elevated road at an expense \$35,000, being changed from a steam-powered highway to a double-decked bridge driven by electricity. The Shailer & Schnaigau Company, Lassing Bridge and Iron Works and Vulcan Iron Works all of Chicago, were the contractors.

The American Stoker Company has recently furnished stoker equipments to the following parties: To the Pennsylvania Railroad Company, for the shops, Columbus, O. (second order); to the Davis & Egan Machine Tool Company, Cincinnati, O.; to the Toledo Brewing & Malting Company, Toledo, O.; to the Michigan Carbon Works, Detroit, Mich. (second order); to the John C. Roth Packing Company, Cincinnati, O.; to the Cleveland City Water-Works, Cleveland, O.

The Murray Iron Works Company, of Burlington, Ia., bought up the business of the Sioux City Engine and Iron Works last spring, and proceeded to build new shops for the manufacture of Corliss engines at Burlington. These have now been completed and put in operation. As the old plant of the Murray Iron Works Company is well equipped for boiler construction and the building of slide-valve engines, the company is in a position to furnish complete power plants, either large or small.

The New York Dredging Company, World Building, New York has completed extensive terminal improvements for both the Norfolk & Carolina Railroad and the Southern Railroad, at Norfolk, Va. An extensive bulkhead has been constructed and the filling in behind it, with spoil, was done by the company's suction dredge Boston, the approaches to the wharves being deepened at the same time. The dredging plant has been towed to Atlantic City, N. J., to reclaim valuable areas of marsh land back of the city, by pumping upon them sand from an island belonging to the owners of the marsh land.

The city of Milwaukee has recently contracted for a new fire boat to be 107 feet long, 24 feet beam and 11 feet deep. The engines are to be double 18 inches by 30 inches with steel frames, and the screw 8 feet diameter. She will have two sets of pumps with a capacity of 6,000 gallons per minute, and an air pump and steam steering gear. This makes the third added to Milwaukee's fire department. The last built, the James Foley, at a trial test threw a four-inch stream of water 545 feet as measured by the city officials. The present boat is intended to be the finest in the world. The contractors for the machinery are the Chas. F. Elmes Engineering Works, of Chicago, who also built the two previously mentioned.

The Pedrick & Ayer Company, of Philadelphia, has recently received from the Safety Car Heating and Lighting Company an order for six Pintach gas compressors to compress to 200 pounds per square inch. The company is also at work upon a pneumatic-hydraulic riveter gotten up by Messrs. Dodge and Caskey, of the Link Belt Engineering Company, and which they are preparing to manufacture and place on the market. The hydraulic riveting ram exerts a pressure of 40 tons, and this pressure is derived from compressed air at 80 pounds per square inch, operating on a piston large enough to give some thousands of pounds per square inch pressure in the hydraulic cylinder. The riveter is compact, and the first ones built have done good work.

For the purpose of extending the trade of the United States in the South American Republic of Venezuela, the National Association of Manufacturers, whose bureau of publicity is at 1751 North Fourth street, Philadelphia, proposes to open in the city of Caracas, the capital of Venezuela, a warehouse for the exhibition of American products of various kinds. A concession granted to the association by the Venezuelan government creates particularly favorable conditions for the establishment of such an enterprise,

inasmuch as goods entered for exhibit will be admitted free of duty, the customs dues to be paid only in case of actual sale. The plans for the establishment of this permanent exhibition of American goods have reached a point where applications for space can now be received, conditioned upon the allotment of a sufficient portion of the total available space to warrant the association in inaugurating the exhibition. The aim of the association is to stimulate trade between the United States and Venezuela by familiarizing the merchants of Venezuela with the American products which they can purchase to advantage. This is the objects of the proposed exhibition warehouse. Resulting orders will go through the customary channels of trade as at present. It is estimated that an entrance fee of \$100 from each exhibitor, and a charge of \$1.50 per annum per square foot of space used for exhibits will yield enough to cover, or nearly cover, the running expenses of the warehouse. The minimum charge for space has been fixed at \$25 per annum. This, with the entrance fee, would make the minimum charge for any exhibit \$125 per annum, in addition to the cost of transportation from the United States to the warehouses in Caracas. The entrance fee and the charge for space used for exhibits constitute all the charges which will be imposed upon exhibitors by the association. Parties desiring additional information should write to the Philadelphia address given above.

Our Directory

OF OFFICIAL CHANGES IN SEPTEMBER.

We note the following changes of officers since our last issue. Information relative to such changes is solicited.

Atlantic & Pacific.—Mr. B. Burns has been appointed Chief Engineer.

Atlantic & Pacific Railroad—Western Division.—W. H. Smith, has been appointed Purchasing Agent, with headquarters at Albuquerque, N. Mex.

Baltimore & Ohio.—Mr. Wm. Sinnott is Division Master Mechanic of the second and third divisions, with headquarters at Cumberland, Md.

Central of New Jersey.—Mr. J. G. Thomas, Assistant Superintendent of Motive Power, has been appointed Superintendent of Motive Power of the Lehigh & Susquehanna Division.

Chicago & Northwestern.—Mr. W. H. Newman has resigned the position of Third Vice-President.

Chicago, St. Paul, Minneapolis & Omaha.—Mr. A. G. Wright has been appointed Division Master Mechanic at Altoona, Wis., vice Mr. W. E. Amann, resigned.

Great Northern.—Mr. W. W. Finley has resigned the office of Second Vice-President. He is succeeded by Mr. W. H. Newman.

Gulf, Colorado & Santa Fe.—Mr. C. W. Felt is Chief Engineer, with headquarters at Galveston.

Iowa Central.—Mr. Chas. W. McMeekin is Chief Engineer, with office at Marshalltown, Ia.

Kings County Elevated.—Gen. James Jourdon is Temporary Receiver.

Long Island.—Mr. W. H. Baldwin, Jr., has been elected President to succeed Mr. Austin Corbin, deceased.

Los Angeles Terminal.—Mr. William Wincup, Acting General Manager and Secretary, has resigned. Mr. S. Hynes is General Manager; Mr. F. K. Rule, Secretary, and Mr. W. J. Cox, Assistant to General Manager.

Louisville, Evansville & St. Louis.—Mr. James Gaston is appointed Master Car Builder, with headquarters at Princeton, Ind., vice Mr. W. E. Looney, resigned.

Louisville, New Albany & Chicago.—Mr. W. H. McDoel, General Manager, has been appointed Receiver.

Monterey & Mexican Gulf Railway.—E. Dragnet is Superintendent of Motive Power, vice H. Nollan, previously Superintendent of Motive Power and Roadway.

New Orleans & Northwestern.—Mr. J. H. McGill has been appointed Master Mechanic in charge of locomotive machinery, water supply and car department.

New York, Philadelphia & Norfolk.—Master Mechanic C. O. Skidmore has resigned.

Norfolk & Western.—R. P. C. Sanderson, Division Superintendent of Motive Power, has resigned, and the office is abolished.

Northern Pacific.—Mr. G. W. Dickinson, General Manager of the Western lines, has resigned. Mr. W. G. Pearce, heretofore Assistant General Manager, is appointed Assistant General Superintendent, with office at Tacoma, Wash. Mr. E. H. McHenry, formerly one of the Receivers, is now Chief Engineer of the reorganized road, with office at St. Paul. Mr. W. L. Darling, formerly Chief Engineer, becomes Division Engineer, with office at St. Paul, and Mr. C. S. Bither is Division Engineer, with office at Tacoma.

Southern.—Mr. W. W. Finley has been elected Second Vice-President, vice Mr. W. H. Baldwin, Jr., resigned. Mr. W. H. Hudson, Master Mechanic at Atlanta, has been transferred to Salisbury, N. C. Mr. W. L. Tracey is transferred from Birmingham to Atlanta, and Mr. W. A. Stone, Master Mechanic at Selma, Ala., is appointed to the position at Birmingham.

Employment.

A mechanical draughtsman, having 16 years' experience in car construction, is desirous of a position as assistant to General Foreman, Inspector of New Equipment, or Draughtsman. Will give best of references. Address, care of this paper,

AMERICAN ENGINEER CAR BUILDER AND RAILROAD JOURNAL

NOVEMBER, 1896.

THE ALTOONA SHOPS OF THE PENNSYLVANIA RAILROAD.

V.
(Continued from page 245.)

In the last article on the Altoona shops the principal features of the Golsdorf and Von Borries compound engines, with which the Pennsylvania Company is experimenting, were illustrated and described. It remains to explain the construction of the other two engine.

THE "PITTSBURGH" SYSTEM.

The general features of construction of this engine are shown by Fig. 1. Figs. 2 and 3 are sectional views of the intercepting valve, which is located between the cylinders. In Fig. 2 the valve is shown in the position it occupies when the engine is working simple. Steam from the boiler can then enter the steam-chest of the high-pressure cylinder through the passage *N* and to the receiver and low-pressure cylinder by the passage *K*. When the parts are in the position shown the steam in *K* moves the reducing-valve *C* from its seat and thus allows steam to flow from *K* into the passages *O* and *P*, as indicated by the darts, and thence to the receiver and low-pressure cylinder. When the intercepting valve *A* is in the position shown, the passage *Q*, which communicates with the exhaust of the high-pressure cylinder, is connected with *M*, which leads to the atmosphere. The high-pressure

cylinder thus exhausts directly into the chimney and the low-pressure cylinder is supplied with live steam from the passage *K*.

To change the engine so as to work compound a cylinder *E*, Fig. 1, is placed on the position shown. This cylinder has a piston which is connected by a rod *F* to a double-armed lever *G*, the lower end of which is connected to the intercepting valve stem *H*. Inside of the cab a double-armed L-shaped lever *D* is provided, the horizontal arm of which has a slot in which a pin on the reverse lever works. This slot has depressions at each end so that when the reverse lever is at its extreme throw in either direction the horizontal arm of the lever *D* will be raised up by a spring *S* at its back end.

The upper end of the vertical arm of this lever is connected to a valve on the cylinder *E*. The throttle lever being open when the reverse lever is thrown backward from its extreme forward position, it acts on the lever *D*, and moves the valve in the cylinder *E*, so as to admit steam to its front end and exhaust it from the back end, thus forcing the piston backward and causing the intercepting valve *A*, Fig. 2, to move forward into the position shown in Fig. 3. This movement first closes communication from the high-pressure cylinder exhaust passage *Q*, and the passage *M*, which leads to the chimney and opens communication from *Q* to the passages *P*, which leads to the receiver and low-pressure cylinder. The steam from the high-pressure cylinder instead of exhausting up the chimney is thus discharged into the receiver and low-pressure cylinder. The movement of the valve *A* causes the piston *B* to come in contact with the valve *C* and thus closes it and shuts off steam from the passage *K*. The engine then works compound.

THE "RICHMOND" SYSTEM.

Figs. 4, 5 and 6 illustrate the chief features of construction of the "Richmond" system. They are similar to the views of the Pittsburgh engine. To work the Richmond engine simple, the

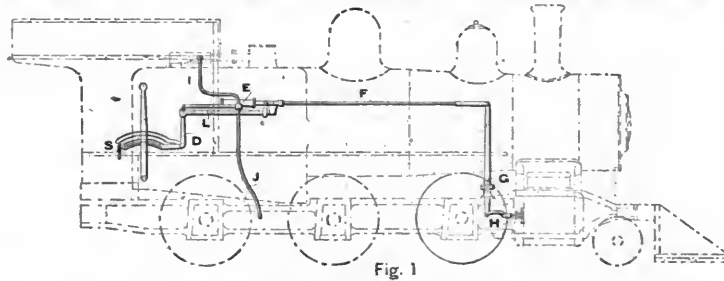


Fig. 1

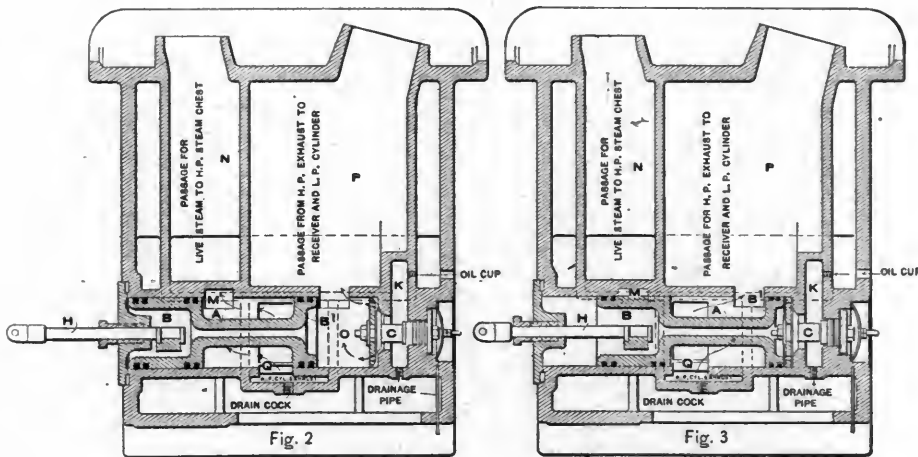


Fig. 2
POSITION OF VALVE WHEN ENGINE IS
WORKING SIMPLE

Fig. 3
POSITION OF VALVE WHEN ENGINE IS
WORKING COMPOUND

Pittsburgh System as applied to a Mogul Locomotive by the Pennsylvania Railroad.

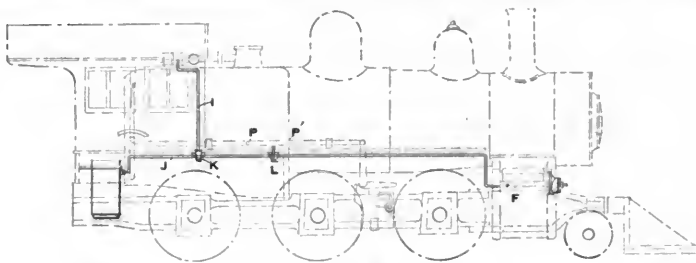


Fig. 4

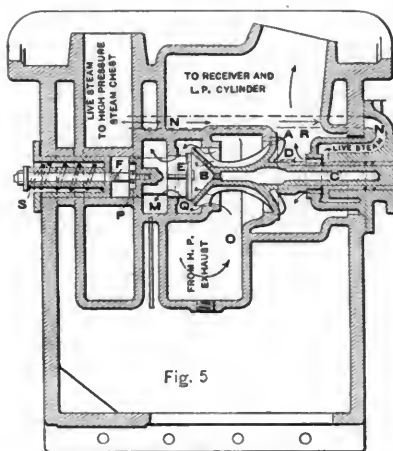


Fig. 5

POSITION OF VALVE WHEN ENGINE IS
WORKING SIMPLE

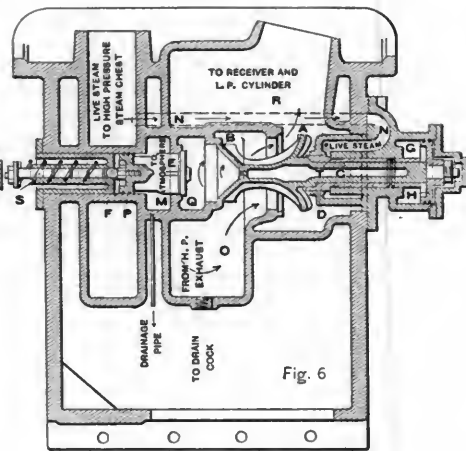


Fig. 6

POSITION OF VALVE WHEN ENGINE IS
WORKING COMPOUND

The Richmond System as applied to a Compound Mogul Locomotive by the Pennsylvania Railroad.

throttle valve is opened and the reverse-lever thrown either full gear forward or full gear back. When this is done one of two tappets *P*, *P*¹ Fig. 4, on the reverse rod engage with the lever of the operating valve *L*, which admits compressed air or steam by a pipe to the chamber *F*, indicated in Fig. 4 and shown clearly in Fig. 5. The pressure of the air or steam acts on the piston *P*, Fig. 5, attached to the emergency valve *E* moving them forward and opening communication between the chambers *M* and *Q*. As *M* communicates with the atmosphere, this movement allows the steam in *M* and *Q* to escape, and thus relieves the pressure in the chamber *Q* back of the piston *B* attached to the intercepting valve *A*. At the same time steam which passes through the passage *N* opens the admission and reducing valve *D* and allows steam to flow into the space *R*, which leads to the receiver and low-pressure cylinder, and closes the intercepting valve *A* and opens *B*. The exhaust can now escape direct from the exhaust passage *O* of the high-pressure cylinder to *Q* and *M*, and thence to the atmosphere, and the low-pressure cylinder is at the same time supplied with live steam which enters the receiver through the pipe *N*.

To change to compound working, the throttle being opened, the reverse lever is withdrawn from its full forward or back positions which disengages the tappet *P* or *P*¹, and the lever of the operating valve *L*, Fig. 4, cutting off the steam or air supply to the cavity *F*, Fig. 5, which allows the action of the helical spring *S* to close the valve *E*, as shown in Fig. 6. At the same time the exhaust steam from the high-pressure cylinder accumulating in the cavity *O*, this pressure soon exceeds that in the opposite side of the intercepting valve *A*. It is forced from its seat and at the same time closes *D*, and thus shuts off the supply of live steam to the low-pressure cylinder through the passage *N*, and opens communications between the passage *O*, or from the exhaust of the high-pressure cylinder to *R*, and to the receiver and low-pres-

sure cylinder, so that the latter then gets its supply of steam from the receiver, and the exhaust of the other cylinder, thus changing the working of the engine from simple to compound.

The sleeve of the valve *D* has an axial movement on the stem *C* of the intercepting valve and by reason of the difference of area of the end of the sleeve and the shoulder cap *T*, the sleeve acts as an admission and reducing valve to the low-pressure cylinder, when starting and when working simple and equalizes the pressure in the two cylinders.

The function of the valve *B* is to insure a quick closing of the valve *A* when *E* is opened.

The tests of the experimental compound engine in the Pennsylvania road are now completed, and have shown a decided advantage for the compound system, but the data and conclusions drawn from these tests have not yet been made public.

CLASS L PASSENGER LOCOMOTIVE.

Reference has been made several times in these articles to what is known as the class L passenger locomotives. These are built from the most recent designs which have been evolved on the mechanical department of the Pennsylvania Railroad. The accompanying engravings show some interesting features in the construction of these engines. Among these are the guides and cross-heads which were designed, and have been patented by Mr. Vogt, the mechanical engineer. Their external appearance is shown in the perspective view of the engine and the details of construction of the guides by Fig. 8.

These are made of cast-iron and are of box shape, the form of which is shown clearly by the transverse section. They are joined together on the vertical center-line and bolted by transverse bolts as shown. Strong ribs on the back give vertical stiffness, and their form gives all the horizontal rigidity required. The cross-head is shown in the same figure and is made of cast

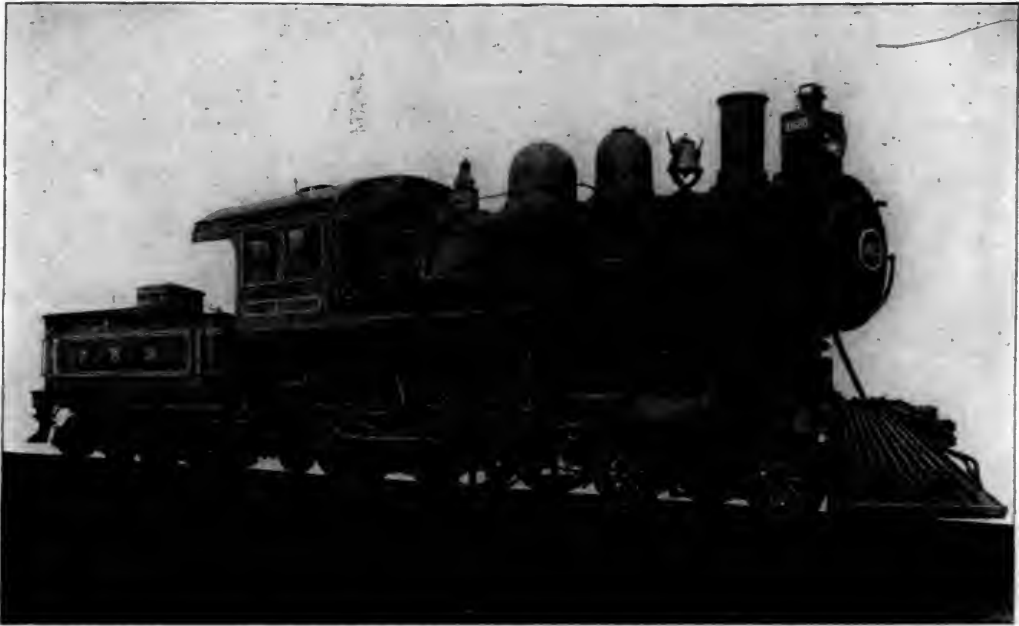


Fig. 7.—Class L Passenger Engine, Pennsylvania Railroad.
F. D. CASANAVE, Genl. Supt. Motive Power. A. S. VOGT, Mechanical Engineer.

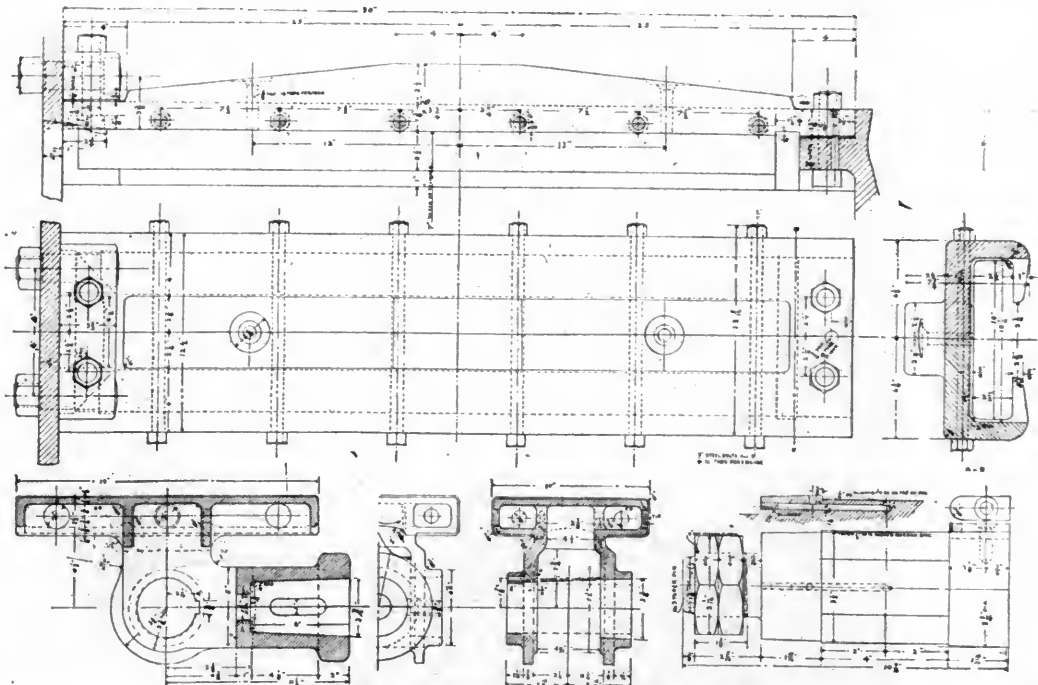


Fig. 8.—Vogt Guide and Crosshead for Class L Engines.

steel, and has been designed so as to be as light as possible. It weighs, including the pin, 146 pounds. To get a measure of its weight, the total maximum pressure on the piston is divided by this weight. The resulting modulus, as it may be called, is 340.6 pounds. In many cases in the older engines, this is 158.7. Of

course, the smaller this modulus is, the heavier is the relative weight of the cross-head. The importance of making all these parts as light as possible is now recognized by all designers of locomotives. It will be seen from the engraving that the cross-head illustrated has a wide bearing on top and against the under

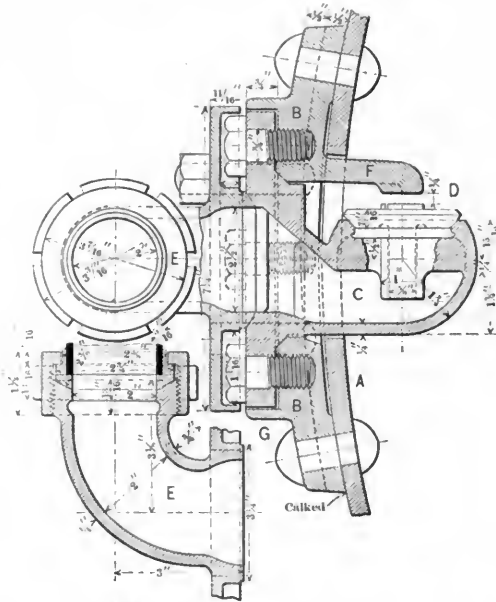


Fig. 9.

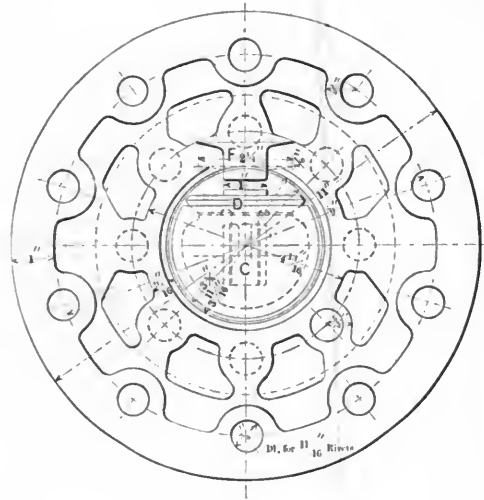


Fig. 10.

Wright's Safety Boiler Check.

side of the wearing surface of the guides. In running forward, the pressure is always upward on this wide bearing. All of the sliding surfaces of the guide are covered with tin $\frac{1}{4}$ inch thick. The steel slides are first planed, and the tin when melted adheres to the steel. A sufficient thickness of tin is cast on the slides to permit of their being planed to the proper dimensions. As shown in the perspective view, the design is a very neat one, and it has worked very satisfactorily.

The pistons used in these engines have heads made of cast steel. To the outside of this a cast-iron piston ring is bolted. This has grooves turned in it to receive the cast-iron packing rings. In the under portion of the piston a segmented piece of an 7-shaped sectional form is fitted so as to cover the joints of the packing rings. It also serves the purpose of preventing the packing rings from turning in the piston ring. The latter is widened out on its under side in order to give a greater bearing on the bottom of the cylinder. This permits the upper portions and the sides of the rings to be made narrower. By this means the stroke of the pistons has been increased from 24 to 26 inches without lengthening the cylinders. The cylinder heads are made to conform to the shape of the piston heads, and suitable cavities are made in the heads to receive the wide bearing of the piston ring.

SAFETY BOILER CHECK-VALVE.

It may be remembered by some of our readers who are no longer young that, some 10 or 15 years ago, a serious accident occurred on the Pennsylvania Railroad near Pittsburgh. A local train was standing at a station and a following express train ran into the rear end of the former. The locomotive "telescoped" into the last car of the local train, and in doing so one of the check-valve cases was knocked off and the hot water and steam in the boiler was discharged into the car filled with passengers. Many of them were killed or frightfully scalded. This accident led to the adoption of a check valve located inside of the boiler, so that in case of collision it would not be injured.

The first form which was extensively used consisted of a flap-valve, an engraving of which is published on page 219 of the revised edition of the "Catechism of the Locomotive." Experience showed that this form of valve was open to some objections, which led to the design illustrated herewith. This was made,

and has been patented, by Mr. William Wright, chief draftsman in the machinery department at Altoona, and is now used on all new engines, and has been made standard by the Pennsylvania Railroad Company, as well as the Southern Railway Company.

Fig. 9 gives a sectional view of the valve, and its seat drawn in a plane transversely to the boiler, and Fig. 10 is a side view looking at the valve from the inside of the boiler; also in the lower left-hand corner of Fig. 9 is a sectional plan of the pipe connection. *AA* represents a portion of the boiler plate. *BB* is a brass flange riveted to the boiler plate, and a valve-seat inside the boiler provided with a mushroom valve, which acts vertically, thus allowing the water to enter the boiler at the valve-seat, and all around its periphery. The stream of water thus washes the seat and has the effect of removing any obstructions which might otherwise lodge between the valve and its seat. It should be understood that injectors all have check-valves of their own, and therefore there is the same pressure above and below the boiler-check, and, consequently, when the injector is shut off, the boiler check-valve is not seated by the pressure above, as is generally supposed, but by gravity alone. Owing to this cause the old hinged flap-valve often becomes inoperative by the deposition of sediment or incrustation on the hinge.

It will be seen from the the engraving that the riveted plate *B* has a projection or finger *F* which projects into the boiler and over the top of the valve, and which acts as a stop to its upward movement or "lift."

The valve-casing *C* is securely fastened to the riveted plate *B* by four bolts and a flange which is protected by a circular guard or flange *GG*. The elbow *E* to which the feed-pipe is attached is fastened to the riveted flange by four studs. The valve and its seat, which would be the source of danger if broken off in a collision or other accident, is thus very securely fastened to the boiler, is all under the jacket, and as close to the boiler as possible, the only projecting portion being the pipe elbow, which is made very light at its juncture with the flanges, so that if it is broken it will not at the same time break any of the parts to which it is attached.

The flange on the elbow projects partly into the jacket, to make a good finish, and on being removed the valve-casing can be taken out through the opening in the jacket and that in the riveted plate. Neither the jacket nor any other parts need be disturbed to take out the check valve, which can thus be readily cleaned as required.

All the parts excepting the studs, bolts and nuts are made of brass, and as light as is consistent with the required strength.

These checks have been applied to about 200 locomotives so far, and, it is said, have given entire satisfaction. In view of the terrible accidents which may occur from the breaking off of an ordinary check valve, the use of some such device as this should be made compulsory on railroads, and such a simple appliance being available, railroad managers incur a grave responsibility if they do not use it.

BALANCED TENDER SCOOP.

Tender scoops, in use heretofore, although answering the purpose for which they were intended primarily, still had one objectionable feature which became more and more apparent with the increased speed of the past few years. This defect consists of the necessity of slowing down to take water from the track trough, thus causing loss of time; also, it was necessary that a definite speed be reached: for, if the speed was too slow, it became necessary to hold down the dipper by means of the operating lever and, if too fast, the dipper could scarcely be raised, even though both engineer and fireman exerted all their strength to do so. Twenty-five miles per hour is about the greatest speed at which such scoops could be raised from the trough, and then if the dipper did not yield at the first pull, it would be dragged over the end of the trough and the mouth of the dipper was thus liable to be crushed. In consequence, it was necessary to constantly repair or replace the dippers.

The tender scoop illustrated by Figs. 11 and 12, on which letters patent have been granted to W. F. Kiesel, Jr., connected with the Mechanical Engineer's office, at Altoona, Pa., was designed to overcome this objection, the aim being to make it as efficient and easily operated at the greatest attainable speed as when running slowly.

The dipper proper, that is the portion extending from *D* to *E*, Fig. 11, is carried on pivoted supports or bolts *T*. The upper part of the dipper is connected to the up-take pipe *M* by an intermediate section *J*, which is supported on the pivots *P*. It is connected to the uptake pipe *M* by a semi-circular joint which is indicated by a dotted line. The short section can therefore turn about the pivot *P*, and can move in contact with the pipe *M*. The junction of the dipper with *J* is of a segmental form drawn from *T* as a center. The dipper can therefore turn about the pivot *T*, and can move in contact with *J* on the segmental joint. It will thus be seen that the dipper is balanced on the pivots *T* attached to brackets *O*, which are cast on and form a part of the intermediate section *J*.

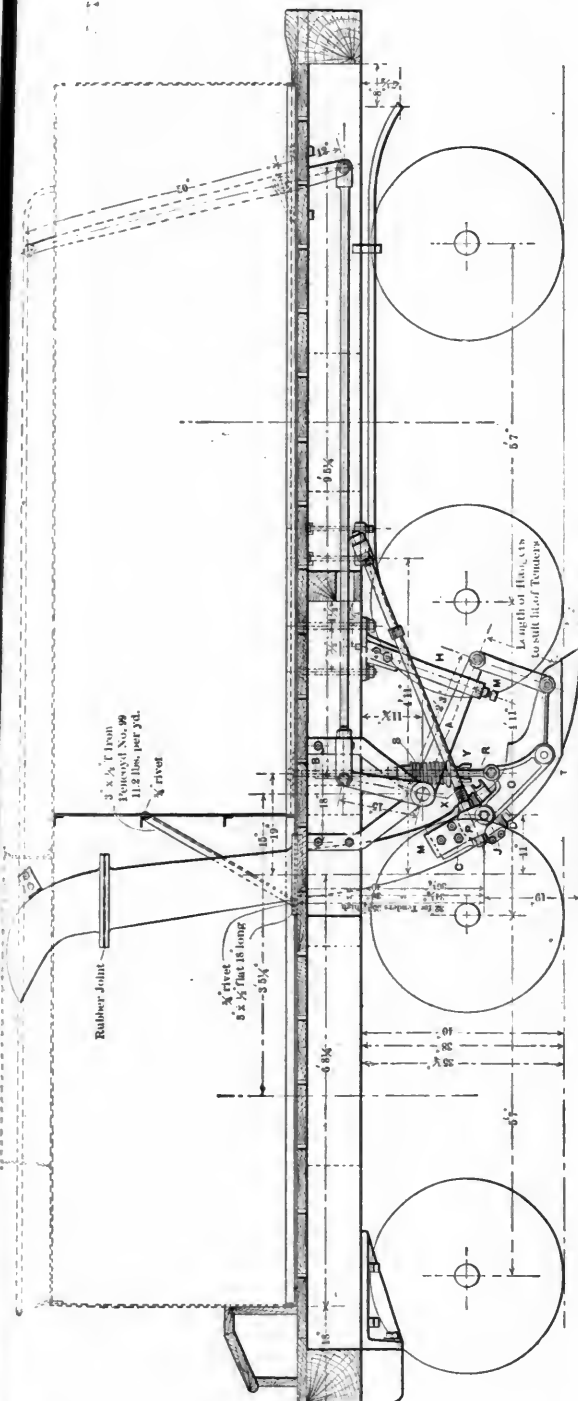
The top of the dipper is open to a point immediately above the pivots T , so that any spray or wave may be carried up with the larger body of water.

The intermediate joint *J* of conduit is pivoted at *P*, and is held by cheek pieces *C*. The cradle itself is attached to two rods *RR*, passing through two light spiral springs *SS*, which are compressed when the dipper is lowered. These springs are set on a yoke *Y*, fixed to the frame of the tender by means of bolts *BB*, and serve only as a balance for the weight of the dipper and other movable parts when the dipper is not in use, so that, if anything should give way, or a pin be lost, the dipper would not drop to the track and possibly cause damage.

The nuts *NN* at the top of the springs project partly inside of the coils and form a definite stop and also a convenient mode of adjusting the position of the mouth of the dipper.

The hanger *H* with adjustable set screw *M* is simply a safeguard against any springing of the tender frame or arm *A*, which would result in lowering the mouth of the dipper in the trough, and a possibility of scraping along the bottom.

When water is flowing into the tender, it exerts a certain pressure on the dipper, which increases with the speed of the engine.



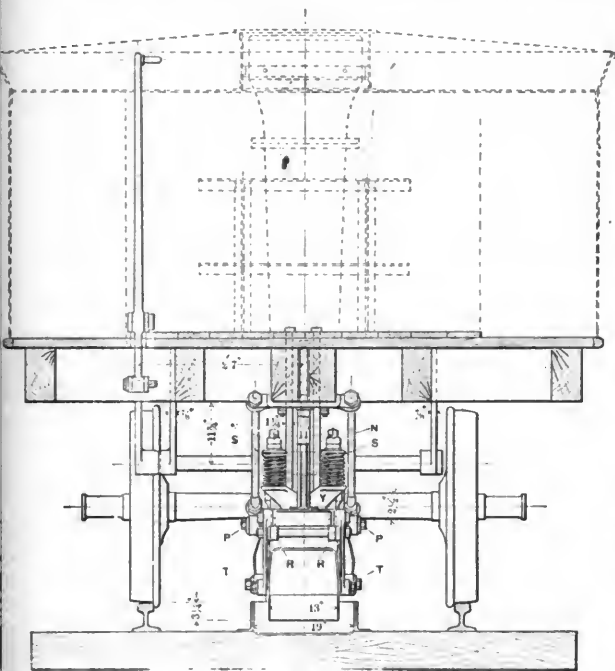


Fig. 12.—Kiesel's Balanced Tender Scoop.

Therefore the dipper is pivoted near its center, so that the pressure in the upper half balances that in the lower half. This makes it entirely independent of speed.

In lowering the dipper the only resistance is that due to the springs *SS*. In raising it out of the water the pressure on the trunnions *T* holds down the cradle and the dipper moves round the trunnions *T* until the stops *X* touch the arms of the cradle. This gives enough motion to the dipper to allow the mouth to rise clear of the water, consequently no more water rushes in and the rest of the movement takes place easily around the pivot *P*.

Lowering and raising can be easily accomplished with one hand at any speed.

The first scoop built was in continual service for eighteen months without costing anything for repairs. For the past two years the Pennsylvania Railroad Company has been equipping all new tenders with this scoop, and there are now more than seventy-five in service. They are giving excellent satisfaction and are very much liked by the engineers, who claim that they can fill their tenders in much less distance than with the old scoop, and besides this they are not obliged to slow down to take water as was the case formerly. They can therefore more easily make up lost time.

Before adopting this scoop, the Pennsylvania Railroad Co. gave it a thorough trial, and found that it proved superior in all respects to anything in that line before used. It has also been proved that with this scoop less water is wasted by being sprayed or thrown out of troughs, that the cost of repairs has been materially decreased and more water per hundred feet run is delivered into the tank. Running at 70 miles per hour a 3,000-gallon tender was filled on a trough 1,000 ft. long in nine seconds.

Before these scoops were adopted it almost became necessary to either increase the length of troughs or use more of them, because it was nearly impossible to fill the tanks with the old scoops when used in connection with the larger locomotives. Now there is no difficulty in this respect, even when running double-header engines. The Pennsylvania Railroad Co. is also equipping their new mogul fast freight engines with this balanced scoop in order

to be able to run through without stopping or even slowing up to take water.

FIREBOX.

From the perspective view it will be noticed that the sides of the firebox are of a somewhat peculiar form. The back part of the waist of the boiler where it joins the firebox is of large diameter, and it was desirable to make the front of the firebox conform to the contour of this part of the waist where they join each other. If the width of the firebox had been made equal to the largest diameter of the waist it would have contracted the space very much between the sides of the firebox and cab. Consequently the front portion of the firebox steel was swelled out to the diameter of the shell, and the swell was carried by a diminishing taper from the front to the back. The tip or Belpaire part of the firebox shell it will be seen is made of less width than the diameter of the waist, which gives more room for outlook between it and the cab.

VALVE GEAR.

The maximum throw of the valves of these engines is six inches, the throw of the eccentrics being $5\frac{1}{2}$, the difference being due to the effect of unequal length of rocker arms. The valves have $1\frac{1}{4}$ inches lap, $\frac{1}{8}$ inch lead when working full stroke in the forward motion and $\frac{3}{8}$ inch lead in the backward motion. The valves have $\frac{1}{8}$ inch inside clearance in the front steam port and $\frac{1}{4}$ inch on the back one. The unequal clearance is given in order to equalize the points of release, and thus make the engines exhaust "square," as it is termed in roundhouse vernacular.

Another feature of the construction which may be commended in those engines is the admirable arrangement of steps and handholds which are provided for the men. Commencing from the front of the engine, it will be seen that a step is attached to the side of the pilot about half way between the bottom and the top, and a semi-circular hand-rail is attached to the lower portion of the smokebox front. Another step is placed to the side of the smokebox, with a short hand rail above it, and on a horizontal line with the center of the smokebox. The usual hand-rail is provided at the top of the boiler, and extends to the front of the smokebox. At the back end of the engine two steps of liberal size are provided, which are held in suitable box-shaped guards. Similar steps are attached to the front and back end of the tender. Over each pair of these steps long vertical handholds are placed, which are within convenient reach from the ground. The step at the back end of the tender is a new feature, and a very excellent one. With all the care that can be taken, and with all the appliances which can be provided, the occupations of locomotive engineers and firemen are still frightfully dangerous, and there is no excuse for omitting such comparatively inexpensive attachments as have been described. Nevertheless they very often are omitted, or are wretchedly inadequate for the purposes for which they are intended. Such omission or neglect is criminal, and ought to be punishable in some way.

(To be Continued.)

The New Heilmann Electric Locomotive.

The *Revue Internationale de l'Electricite* is unsparing in its criticisms of the new Heilmann locomotive. From a recent article translated by the *Electrical Review*, we take the following: The Heilmann locomotive, which was tried in 1893 on the Western Railway of France, has now been constructed or is now re-constructing, of a size to develop 1,350 horse-power. Improvements suggested are better suspension of the motors, a new type of steam engine, and modified driver's apparatus. The boiler is to be of ordinary locomotive type. The heating surface will be 180 square metres (1,937.5 square feet), and the grate surface 3.3 square metres, or about 35 feet—a pretty large area for a European locomotive. The engine is to be a Williams and Robinson, with six cranks. The Heilmann scheme simply brings electrical working into contempt, for it cannot prove an economy. It carries an immense boiler and a six-crank steam engine, and its one advantage is that in going uphill the steam engine can be run at speed, and will not therefore lose power, as is now the case with a locomotive, which as it travels slower, also revolves slower, and loses power

thereby. But this is to some extent a fable. When a locomotive mounts a hill it revolves more slowly, and, therefore, gets more pressure, and for an occasional hill it is not usually necessary to take along the whole roundhouse. However, our readers may judge for themselves. The two generators, of a pressure of 450 volts, are excited by a dynamo, driven by its own 28 horse-power engine, the motors are fixed to the frame of the bogies, and have an elastic connection with the axles. The power is 1,000 horse power at the rail. The drawbar pull is a little under half the cylinder output. The tyre pull is about 75 per cent. of the cylinder indication, so that of 1,000 horse power, 250 is lost in the transmission and 250 in the engine considered as a carriage, and the new engines are to be capable of hauling 350 tons at a speed of 100 kilometers about 80 miles). It is thought that at present the advantage as to coal consumption rests with the ordinary locomotive. The first Hellmann engine weighed 115 to 120 tons, and only developed 450 horse power, but the new machines are to develop 1,000 at the rail, and apparently only weigh 120 tons, or at the rate of 100 kilograms per horse power, as compared with the weight of torpedo boat machinery only 16 kilograms per horse power, a comparison of little moment, however, considering the difference of conditions. It is expected that these new moving stations will be ready for trial at an early date. We do not doubt that the locomotive will run; that it will do so at a high speed; that it will haul good loads; that it will be a hill climber. We may admit all this, and more; and we think we shall still be free to paraphrase a famous French saying and repeat, "It is magnificent, but it is not engineering."

The Bates Thermic Engine.

For a year or more brief notices have appeared of a new gas motor that was to do wonders, but an air of mystery surrounded it, until a few weeks ago, when a 100 horse-power engine was put on exhibition in Philadelphia. This engine, known as the Bates Thermic engine, is of the vertical type, and has two single-acting cylinders 15.75 inches in diameter and 15.75 inches stroke, and has been run at various speeds up to nearly 200 revolutions per minute.

The cylinders are in three sections, one above the other. The lower one is the barrel, in which the piston and its packing slides; this is kept cool by a water jacket. The section immediately above this is the space in which the gas is burned, expanded and made to perform its work on the piston. The water from the jacket of the lower section rises into the jacket of this one and controls its temperature. The circulation of water is so slow, however, that it turns to steam before it leaves the jacket of the third section, in which the admission and exhaust valves are placed, and which forms what might be called a valve chest.

The exhaust gases from the cylinders pass into two regenerators, which take the place of one side of the A frames which usually support the cylinders of a vertical engine. In these regenerators the exhaust parts with a portion of its heat to compressed air forced through it by a horizontal compressor driven from the crank shaft. Part of this compressed air is used in the combustion of the gas in the engine cylinders, while the remainder of it goes to a gas producer standing behind the engine. Here it is joined by the steam generated in the jackets of the engine cylinders and passes up through the fuel, making a kind of producer gas, called "Gardie" gas after the inventor. The gas is generated under a pressure of about 70 pounds and is led through a "dust separator" to the throttle valve of the engine, from whence it goes to the cylinders.

Each cylinder has three valves in the top head, one for gas, one for air and the third for the exhaust. These three valves are all of the poppet type and are operated by cams on a horizontal shaft extending across the tops of the two cylinders and driven by bevel gearing and a vertical shaft, which in turn is driven by the main shaft. The governor, acting on the admission valves only, is of the ball type and is said to give perfect regulation. The variation in speed is very perceptible, however. It should be said that the gas is not exploded in the cylinder but burns as it enters until the admission valves close, when it expands as in the steam engine. The indicator card thus resembles those taken from a

steam engine, rather than the ordinary gas-engine cards. The initial pressure is under 100 pounds.

From this brief description it will be seen that this engine is simply a gas engine fitted with a regenerator and a gas-producer. There is nothing mysterious about it and its advantage over other gas engines, if it proves to have any, will be in the fact that a part of heat lost in the jacket and exhaust of other gas engines, is utilized in this one. This is certainly a desirable object to attain. The resulting economy in this case has not been great, however, as the coal consumption under test is about 1.2 pounds of coal per horse-power per hour, a figure which has been beaten by well-designed gas engines of the common Otto-cycle.

As already stated, the main shaft drives an air-compressor for furnishing air to the gas-producer and the main cylinder. A small water pump is also driven from the main shaft to supply water to the cylinder jackets. In order to start the engine after it has become cold, a steam boiler and an independent air-compressor must be employed to furnish steam and air, until the producer is in running condition, or for say nearly one hour for a 100 horse-power engine. A very small dynamo is also needed to heat two thin plates in each cylinder, which are employed to ignite the gases, but which keep hot enough for that purpose without an electric current once the engine is started.

It will thus be seen that a rather formidable array of machinery is needed, and it is not clear where the saving is to come in over a good gas engine with an independent gas producer, in the operation of which the heat of the jacket and exhaust is in some measure saved by regeneration in one form or other. In fact this type of engine is somewhat handicapped by the fact that everything is under pressure, even the production of gas, and the air needed for this process must be compressed to 70 pounds pressure. The net output of this particular engine is 100 horse-power but it generates about 140 horse-power, of which 40 horse-power is used by the compressor.

Communications.

Metal Cars in France.

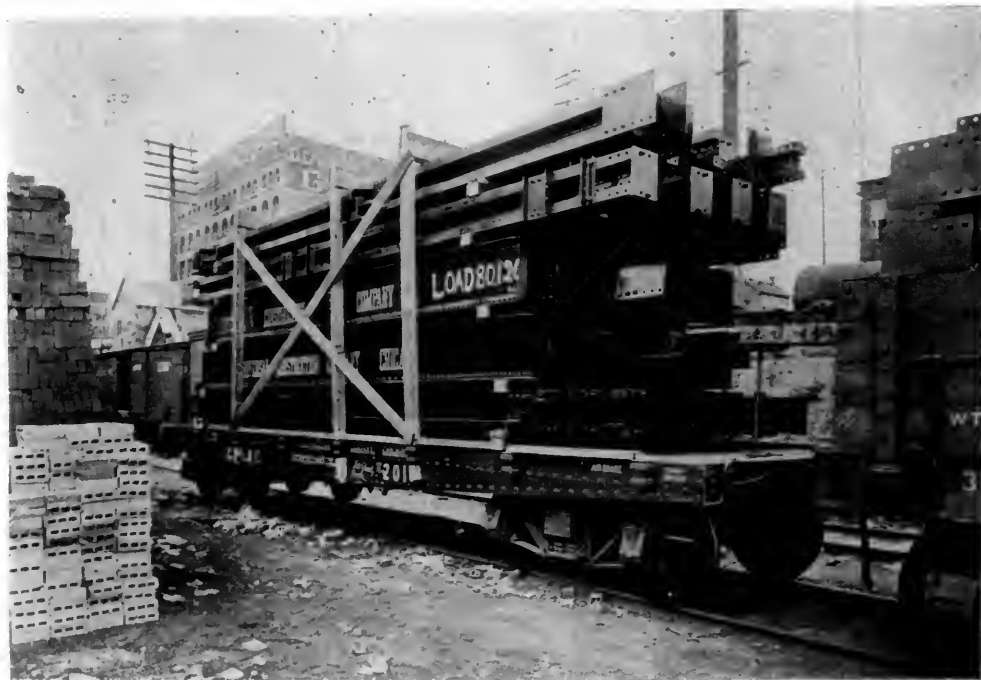
EDITOR AMERICAN ENGINEER, CAR BUILDER AND RAILROAD JOURNAL:

Mr. Tolmer's article on the results of from twenty to thirty years' experience with metal under-frames for cars on the Eastern Railroad of France, published in your August issue, is of great interest and value to American railroad men.

The writer has recently had occasion to examine metal under-frames of a number of locomotive tenders formed principally of heavy angle iron, and which had been in service from five to eleven years. Even in this comparatively short period the angle irons forming the sills and cross-ties were very badly rusted, many of them fully as bad as the section shown in Mr. Tolmer's article from cars that had been in service over twice this length of time. It was found also that the corrosion occurred almost entirely in those portions of the sills which are exposed and not covered by attaching other members of the frame to them. At these points comparatively little corrosion had taken place. The cause of this condition was, of course, due to the exposed parts not being kept covered with paint. Had they been kept thoroughly painted, I have no doubt they would still be in almost their original condition. The very excellent results obtained from metal under-frames on the Eastern Railway of France is undoubtedly due to their being carefully protected by paint, which is renewed at sufficiently frequent intervals to keep the surface well covered. There is no doubt that there are many places in metal under-frames that are difficult to reach with a paint brush, but there seems no reason why this should be neglected if the now well-known device for applying paint with a spray formed by compressed air, flowing through a suitable nozzle, is used. There is no doubt the thorough protection of metal under-framing by liberal use of paint well maintained is an important matter and too often neglected in American railroad practice.

E. M. H.

Mr. W. B. Greenlee, in the *American Geologist*, estimates that the volume of water absorbed in the earth's crust to a depth of one mile, and over the entire land area of the globe, is 8,498,000 cubic miles.



Universal Construction Company's Steel Car Loaded With 40 Tons of Structural Steel.

A Heavily Loaded Flat Car.

Water-Tube Boilers on French War Ships.

On Sept. 22, 1896, on train No. 583, of the Chicago & Northwestern Railway, leaving Chicago at 8:45 p. m., there was taken to St. Paul car No. 201, built by the Universal Construction Company entirely of steel and loaded with 80,120 pounds of structural steel for the Northern Pacific Office Building, or which the Universal Construction Company has the contract. The accompanying cut, from a photograph taken at St. Paul, shows the size of the load and the method of securing it. Careful inspection on arrival showed that the car and its freight had traveled in perfect safety and good order, and as the train referred to is a fast merchandise train and arrived at 2 a. m. on the 24th, showing that only 2½ hours were taken in transit, it is evident that this large and unique load did not in any way interfere with the usual rapid movement of this train. It speaks well for the construction of the car and trucks and the disposition of the 40 tons of material placed thereon.

The Universal Construction Company is continuing its experiments and its development of the metal car. It is just completing the construction of a modified form of flat car built on the Pennock plan, but somewhat simplified. It is also operating gondola cars in the coal business, carrying from 68,000 to 75,000 pounds at a trip, while its ore cars (one of which was exhibited at Saratoga), are carrying from 78,000 to 89,000 pounds at a trip. No weakness or defect has developed up to the present time in any of these cars, and the company is so well pleased with the result of its experiments, that it is bringing out further designs for refrigerator, stock and hopper cars. It has recently received inquiries from South America for equipment built on these lines.

The Cleveland, Cincinnati, Chicago & St. Louis Railway Company has abandoned the use of dummy couplers for hanging up air hose on its freight cars, and these cars will be accepted in interchange without the dummy couplings. Bills for repairs or replacement of same will not be accepted.

A Paris correspondent of the *Steamship*, writing on the subject of water-tube boilers in the French Navy, says: "The question of the tubular boilers, which Mr. Allan repeatedly raised in the House of Commons last session has sprung up here in consequence of the partial disablement necessitating the detention of two ironclads at Brest. These vessels, the *Bouvines* and the *Amiral-Trehouart*, form part of the northern squadron. They put into Brest last week, on arriving from St. Malo, and an examination of their boilers revealed defects in a certain number of the tubes. The latter needed to be replaced 'to avoid accidents similar to those which recently occurred on board the *Jaureguiberry*.' After Mr. Allan's unwearied denunciations of the Belleville tubular boiler—one of his grounds for attack being that it was a French invention practically untested—and after the reiterations from the Treasury bench that the tubular boiler adopted had, on the contrary, undergone the most convincing tests, that it offered enormous advantages in respect to the time demanded for getting up steam, etc., and that the British Navy could not afford to be in arrears, it seems strange to find a French naval critic assailing the tubular boiler, and urging a return to the cylindrical boiler. Another interviewed person on the same side severely blames the Ministry for the Marine for fitting new war vessels, such as the *Chateaurenault*, the *Guichen* and the *d'Estrees*, with the tubular, or, as they are termed here, multitubular boilers. He quotes the example of the Italian Marine Department, which, as the result of the catastrophe on board the *Jaureguiberry*, at once substituted the cylindrical boiler defended by Mr. Allan for the tubular variety fitted to the cruiser *Varesa*, then in course of construction. The breakdown of the *Amiral-Trehouart* was pronounced at Brest to be due to deposits inseparable from the system of the water-tube boilers. Three types of these boilers exist at present in the French Navy, and as it happens, they are placed upon three cruisers of an identical class—the *Chasseloup-Laubat*, the *Friant* and the *Bugeaud*. The *Belleville* may or may not resemble either of the types in question, but those who have criticised its adoption for British war vessels may be interested to learn that a strong cry has been raised on this side of the Channel for a further series of tests, and for the return to the cylindrical boiler at any rate until the superior character of the water tube boilers has been placed beyond all doubt by a perfection of the system.

**Small Plant for Handling Coal and Ashes for Locomotives.
Cleveland, Cincinnati, Chicago & St. Louis Railway.**

Some months ago we described the plant for handling coal and ashes for the locomotives of the Cleveland, Cincinnati, Chicago & St. Louis Railway at Wabash, Ind. That plant is completely equipped with conveyors and manual labor is reduced to a minimum. But it is not always possible to put up such a plant, a case in point being the terminals of this same road at Louisville, where there is not room near the roundhouse for a regular coal chute, with conveyors.

ash pit, served with a crane, and further away from the roundhouse is a second crane on the coaling platform. The cranes are shown in Fig. 2, and in Fig. 3 is shown one of the ash cars placed in the ash pit.

The cranes are of the pillar type, and are worked by compressed air, and have a capacity of 3,000 pounds. The cylinder is 12 inches in diameter, and has a 9-foot stroke. Its piston carries a sheave at its outer end and a $\frac{1}{2}$ -inch wire rope with one end secured at a fixed point passes around this sheave and over the one at the end of the crane. The load thus moves twice as fast and twice as far as the piston of the air cylinder. The other

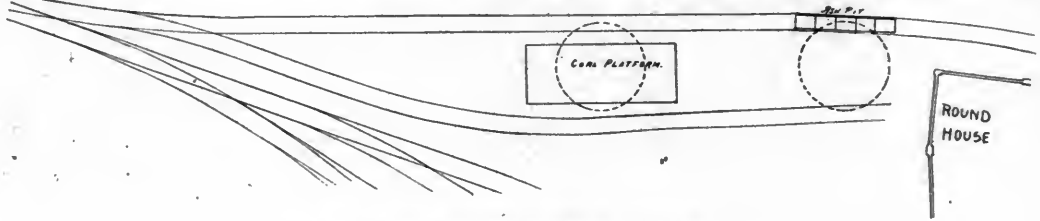


Fig. 1.—Plan of Coaling Tracks at Louisville.

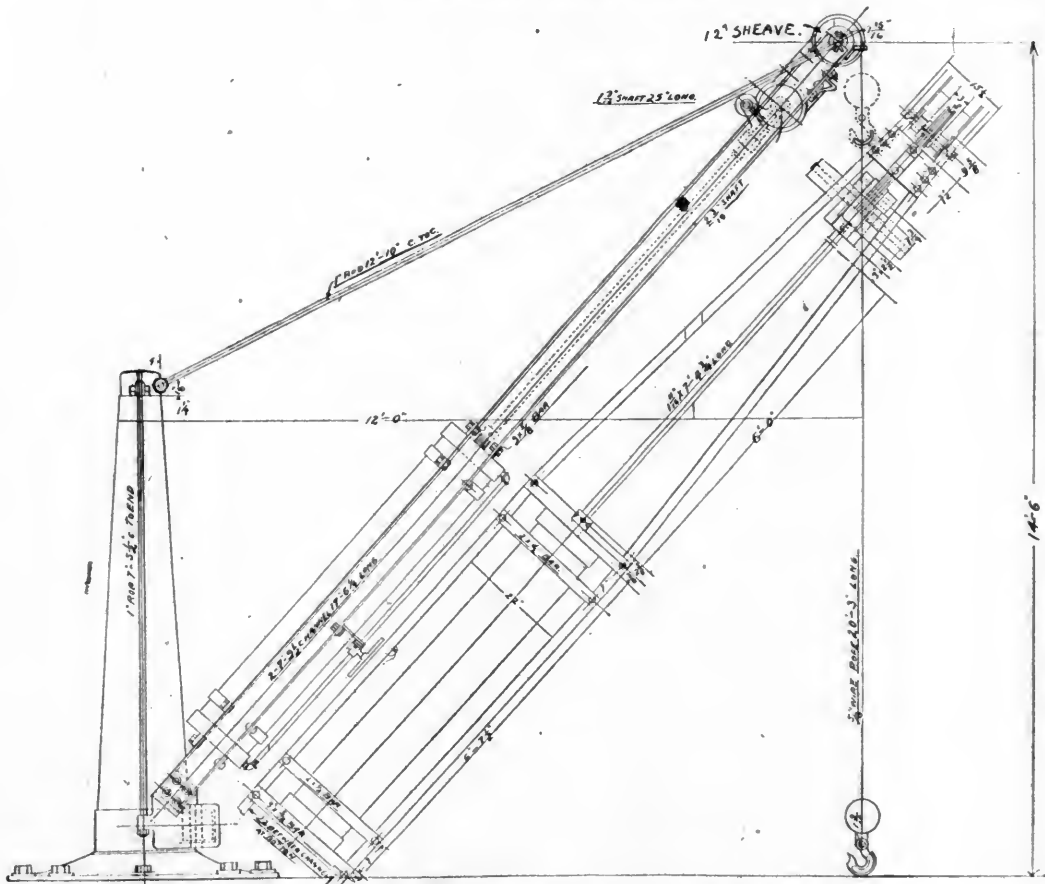


Fig. 2.—Pneumatic Crane for Handling Coal and Ashes at Louisville—C., C., C. & St. L. Ry.

At this point the problem of reducing the expense of handling coal and ashes has been solved in a way which will be readily understood from the accompanying engravings. Fig. 1 shows the arrangement of tracks at the coaling station. The upper track is the in-going track to the roundhouse. In this track is located an

details of the cranes will be readily understood from the drawing.

In the bottom of the ash pit there is a track of 30 inches gage, on which travel cars such as shown in Fig. 3. The bodies of these are made of $\frac{1}{8}$ -inch plate, put together at the corners with $1\frac{1}{2}$ -inch angle iron, and stiffened at the top edge with $1\frac{1}{2}$ inch by $\frac{1}{2}$ -inch

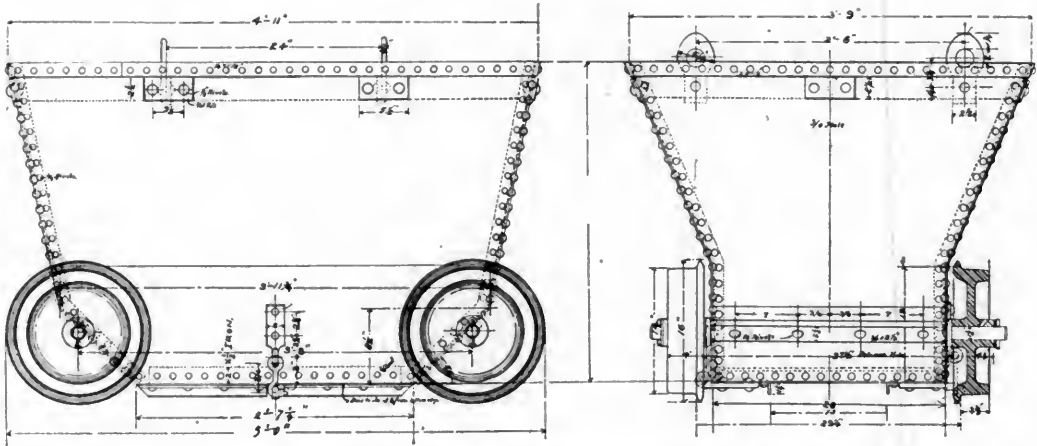


Fig. 3.—Car for Ash Pit at Louisville.—C., C. & St. L. Ry.

iron and at the bottom with 2-inch by $\frac{1}{4}$ -inch iron. The bottom is a door hinged at one side, and held at the other with the hook seen in the side elevation of Fig. 3. Across the top of the box are two iron crossies, to each of which is secured two eyes, by which the car is lifted bodily out of the pit when it has been filled with ashes.

The pit is long enough for five of these cars, and they are handled by one of the air cranes, by which they are lifted out of the pit, swung over to the next track, and their contents emptied through the drop bottoms into a car kept standing on the coal-storage track.

The coaling operations are conducted by means of the other air crane. There are 12 coal buckets on the platform, each capable of holding about one ton, and these are so arranged that they can be conveniently filled from a car standing on the coal-storage track. When an engine is to be coaled the contents of as many of these buckets as necessary are delivered on the tender by means of the crane. At present between 15 and 20 engines are coaled daily with this plant.

The arrangement has proved so satisfactory for a small plant that a similar outfit is being installed by the same road at East St. Louis, Ill.

Experiments on a Steam Engine at Liege University, Belgium, by Professor Dweishauvers-Dery, 1896.

NOTES BY MR. BRYAN DONKIN, M. I. C. E.

For the last few years Professor Dweishauvers-Dery has been making, with his students, some interesting experiments on his single cylinder horizontal surface-condensing steam engine, provided with a brake pulley, cooled by water. Steam is introduced into the three jackets, barrel, and covers, or not, at pleasure. Superheated or saturated steam is used. All measurements are made so that a heat balance is obtained in each experiment. The cylinder of the engine is 1 foot diameter, and the stroke 1 foot 11 $\frac{1}{2}$ inches. These experiments have been going on for some years, and it may be interesting to give a brief summary of some of the results which Professor Dweishauvers-Dery has arrived at.

Experiments with a brake pulley to obtain the mechanical equivalent of heat.—The professor made several very exact experiments to obtain the mechanical equivalent of heat due to the rise in temperature of a certain quantity of water cooling the hollow brake. This brake absorbed a certain quantity of power, and so much heat was put into the pulley. By a water cooling arrangement this heat was continuously taken away by the water, cold water going in and hot water running out. The quantity of such water was very accurately measured by means of a circular orifice, previously gaged by

tanks with extreme care. He thus had all the means of ascertaining the power absorbed by the brake, the quantity of water, and its rise in temperature. The mechanical equivalent of heat, as found by Rowland, is now generally admitted to be 778 foot-pounds per Fahrenheit unit. This, in metric measurement, is equivalent to 426.83 kilogramme-meters per calorie. The mean of six-brake experiments made by the professor works out at 427.22 kilogramme-meters, or higher than the first figure by a tenth of 1 per cent.—a very satisfactory result. The mechanical efficiency of the engine in these experiments was 88 per cent., or, in other words, 13 per cent. of the total indicated power was absorbed by working all the parts of the engine itself.

Experiments relating to the advantage of draining the steam-chest, using steam jackets, and also superheated steam.—To determine the consumption of steam in pounds of water per indicated horse power hour, the professor calculated the experimental results as follows: He took the number of thermal units actually used by the engine per indicated horse power per hour. Then taking the number of thermal units per pound of steam as 1,179, he obtains the number of pounds of water per indicated horse power hour. This is the right method when it is desired to compare the pounds of water per indicated horse power hour from different steam engines, and particularly when some engines use superheated and some saturated steam; or if they work with different steam pressures. With regard to draining the steam chest or the steam jackets, the hot water can either be sent down the drains to waste or the heat in them utilized by being pumped into the boiler. It is, therefore, necessary to calculate separately the pounds of water per indicated horse power hour in these two very different cases, and this has been done in the following tables. In this way the economy has been obtained separately for each of these three great questions, viz., draining of the chest, steam jackets, and superheating the steam. Engine working condensing in all cases:

TABLE A.

No.	Kind of Steam.	Draining the hot water from steam chest or not.	Steam in three jackets, barrel, and two covers or not.	Consumption of steam in lbs. per I. H. P. hour.	
				The hot water being wasted.	The hot water sent to boiler.
1.	Saturated steam.	Not draining.	No steam in jackets.	32.64	0.00
2.	do.	Draining.	ditto	30.43	29.61
3.	do.	Not draining.	Steam in jackets.	24.57	21.00
4.	do.	Draining.	ditto	21.81	11.10
5.	Superheated steam (72 deg. F. of superheat)	Not draining.	No steam in jackets.	25.66	0.00
6.	do.	Draining.	ditto	27.06	26.92
7.	do.	Not draining.	Steam in jackets.	19.47	19.16
8.	do.	Draining.	ditto	19.83	19.42

Steam pressure, 50 lb. Cut-off, one-tenth. Working, condensing.

TABLE B.

The economy due to the draining of the steam chest only is obtained by comparing

	In the case of	The economy is part of hot water	
		Being wasted.	Being utilized.
2 and 1	Saturated steam and no steam in jackets.....	Per cent. 6.87	Per cent. 9.29
4 and 3	" " " " steam in jackets.....	11.27	12.08
6 and 5	Superheated steam and no steam in jackets.....	5.87	5.33
8 and 7	" " " " steam in jackets.....	1.82	1.31

The sign minus (—) indicates a loss instead of a gain.

TABLE C.

Economy due to using steam in the three jackets is obtained by comparing

	In the case of	Percentage of economy, as follows, the drained water being	
		Lost	Utilized.
3 and 1	Saturated steam and not draining the chest.....	Per cent. 24.72	Per cent. 25.47
4 and 2	" " " " draining the chest.....	28.27	28.73
7 and 5	Superheated steam and not draining the chest.....	23.80	25.02
8 and 6	Superheated steam and draining the chest.....	26.72	27.86

TABLE D.

The economy due to superheating only (amount of superheat 72 deg. Fahr.) is obtained by comparing

	In the case of	Percentage of economy, the drained hot water being	
		Lost	Utilized.
5 and 1	No steam in jackets and not draining chest.....	Per cent. 21.70	Per cent. 0.00
6 and 2	" " " " draining the chest.....	10.98	9.07
7 and 3	Steam in jackets and not draining the chest.....	20.75	20.16
8 and 4	" " " " draining chest.....	8.06	7.97

The best experiment in this single-cylinder engine in the consumption of steam was with superheated steam of 72 degrees Fahrenheit (of superheat), both in the cylinders and jackets, and not draining the chest, which resulted in 19.45 pounds of steam per indicated horse power hour. The least economical was with saturated steam without jackets and without drainage, when the engine used 32.6 pound per indicated horse-power hour. Comparing these two results, there is an advantage of 41 per cent. in favor of the combined effect of using superheated steam both in the jackets and inside cylinder, as compared with no jacket and no draining, and saturated steam. It is well to add that this steam engine was not made for greatest economy, but for educating the University students in all the practical details of making engine tests, taking diagrams, and accurately recording results—an education which has had great success at Liege, and is very popular with the young men.—*The Engineer.*

The New Torpedo Boats.

On October 6th the contracts for the new torpedo boats for the U. S. Navy were awarded as follows: To the Bath Iron Works, Maine, two 30-knot boats of 230 tons displacement for \$235,000 each; these boats will be 180 feet long, 18½ feet beam, 11½ feet deep, 5 feet 3¼ inches draft. To the Union Iron Works, one 30-knot boat of 273 tons displacement for \$227,500; it will be 210 feet long, 20½ feet beam, 14½ feet deep, 6 feet draft. To Wolff & Zwicklen, Seattle, two 22½-knot boats of 117 tons displacement for \$75,100 each; these will be 146 feet long, 15½ feet beam, 10½ feet deep, 5½ feet draft. To the Herreshoff Manufacturing Company one 22½-knot boat and two 20-knot boats: the 20-knot boats will be of 46½ tons displacement and will cost \$37,500 each; they will be 100 feet long, 12½ feet beam, 3½ feet draft and 850 horse-power. To Columbia Iron Works, Baltimore, and the Charles Hillman & Co., Philadelphia, one 20-knot boat each for \$49,000 and \$48,500 respectively. These two boats will be alike and have 65 tons displacement, 101½ feet long, 12½ feet beam, 4½ feet draft and 850 horse power. It is reported that these 20 knot boats, so much slower and smaller than craft of this character now built by other nations, are of such dimensions that they can be sent through the canals to the great lakes if occasion should require it.

New Equipment on the Baltimore & Ohio Railroad.

On the occasion of a recent visit to the Mount Clare shops of the Baltimore & Ohio Railroad we had the pleasure of seeing one or more engines of several classes embraced in the order of 75 given out some months ago. Most of these engines have been delivered now, and Mr. Harvey Middleton, General Superintendent of Motive Power, has kindly furnished us with the principal dimensions of several classes of them and with photographs from which the accompanying engravings were made.

The new passenger engines are of the ten-wheeled type, and are of two classes, differing from each other chiefly in the diameter of the drivers and the size of the cylinders. The larger engines have cylinders 21 by 26 inches, and driving wheels 78 inches in diameter. Unless we are mistaken these are the largest drivers ever used in this country on ten-wheeled engines. The cylinders and boilers are large, and give these engines great power. They are intended for service on the heavy express trains between Philadelphia and Washington. There are a number of interesting details in their construction, and we hope in the near future to illustrate these details from working drawings. In the meantime we present an engraving from a photograph which gives an idea of their handsome appearance. The leading dimensions of the two classes of engines are as follows:

21-INCH BY 26-INCH AND 20-INCH BY 26-INCH, TEN-WHEELED PASSENGER ENGINES BUILT FOR THE B. & O. R. R. BY THE BALDWIN LOCOMOTIVE WORKS.

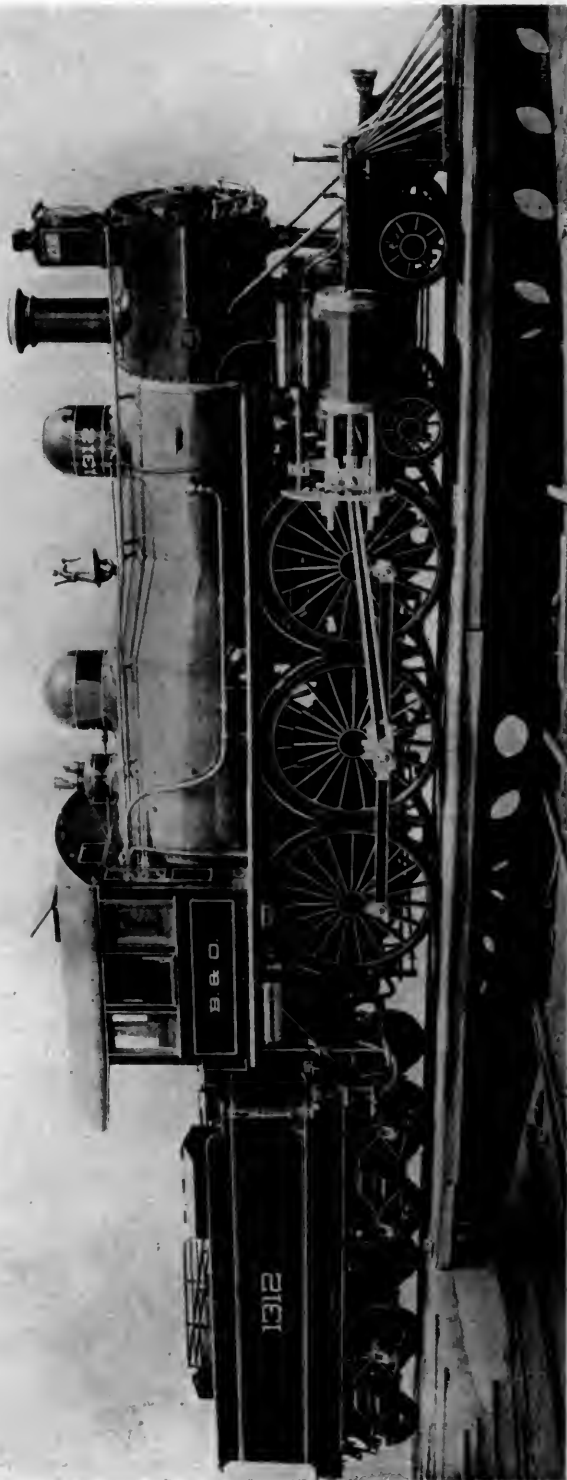
Type and number ordered.....	Ten wheel	6 Single Expansion	4
Simple or compound.....	24 ft. 6 in.	24 ft. 6 in.	24 ft. 6 in.
Total wheel base.....	13 ft. 8 in.	13 ft. 8 in.	13 ft. 8 in.
Rigid wheel base.....	51 ft. 8¼ in.	51 ft. 8¼ in.	51 ft. 8¼ in.
Total length of engine and tender.....	61 ft. 9 in.	61 ft. 9 in.	61 ft. 9 in.
Diameter of cylinders.....	21 in.	20 in.	20 in.
Sroke of piston.....	26 in.	26 in.	26 in.
Diameter of piston rods.....	3¼ in.	3¼ in.	3¼ in.
Size of steam ports.....	19 in. by 1¼ in.	19 in. by 1¼ in.	19 in. by 1¼ in.
Size of exhaust ports.....	19 in. by 2¼ in.	19 in. by 2¼ in.	19 in. by 2¼ in.
Greatest travel of slide valves.....	6 in.	6 in.	6 in.
Outside lap of slide valves.....	1 in.	1 in.	1 in.
Lead of slide valves in full stroke.....	¾ in.	¾ in.	¾ in.
Diameter of driving wheels, outside.....	78 in.	68 in.	68 in.
Kind of truck wheels.....	Wrought center	Wrought center	Wrought center
Diameter of truck wheels.....	33 in.	30 in.	30 in.
Size of driving axle journals.....	8 in. by 10 in.	8 in. by 10 in.	8 in. by 10 in.
Size of truck axle journals.....	5 in. by 10 in.	5 in. by 10 in.	5 in. by 10 in.
Size of main crank pin journals.....	6 in. by 6 in.	6 in. by 6 in.	6 in. by 6 in.
Description of boiler.....	Wag. top	Wag. top	Wag. top
Diameter of boiler at smallest ring.....	60 in.	60 in.	60 in.
Material of boiler.....	Steel	Steel	Steel
Thickness of plates in boiler barrel.....	¾ in.	¾ in.	¾ in.
Thickness of plates in firebox shell.....	¾ in.	¾ in.	¾ in.
Thickness of plates in sides, back end and crown of firebox.....	¾ in. ¾ in. ¾ in. ¾ in.	¾ in. ¾ in. ¾ in. ¾ in.	¾ in. ¾ in. ¾ in. ¾ in.
Thickness of plates in front and back tube sheets.....	¾ in.	¾ in.	¾ in.
Kind of horizontal seams.....	Butt	Butt	Butt
Kind of circumferential seams.....	Double riveted	Double riveted	Double riveted
Material of tubes.....	Iron No. 12 w. g.	Iron No. 12 w. g.	Iron No. 12 w. g.
Number of tubes.....	231	231	231
Outside diameter of tubes.....	2¼ in.	2¼ in.	2¼ in.
Length of tubes over firebox shell.....	14 ft. 17½ in.	14 ft. 17½ in.	14 ft. 17½ in.
Inside length of firebox.....	120½ in.	120½ in.	120½ in.
Inside width of firebox.....	41 in.	41 in.	41 in.
Depth of firebox from crown sheet to bottom of mud ring.....	F. 73½ in. B. 61.	F. 73½ in. B. 61.	F. 73½ in. B. 61.
Water spaces, sides and back.....	4	4	4
Water spaces, front.....	4	4	4
Crown plate stayed with (one 1-in. d. front, bolts ¾ diameter).....	Radial stays	Radial stays	Radial stays
Diameter of dome.....	31½	31½	31½
Height of dome (from top of rail).....	14 ft. 8 in.	14 ft. 8 in.	14 ft. 8 in.
Steam pressure, pounds.....	190	190	190
Kind of grate.....	Rocking	Rocking	Rocking
Grate surface, square feet.....	24.27	24.27	24.27
Heating surface of firebox, square feet.....	215.2	215.2	215.2
Heating surface of tubes, square feet.....	1,978.52	1,978.52	1,978.52
Total heating surface, square feet.....	2,193.72	2,193.72	2,193.72
Height from top of rail to top of smokestack.....	15.0 in.	14.7 in.	14.7 in.
Tires, kind and make (Standard).....	Steel	Steel	Steel

Tender.

Wheels.....	36	33
Axles.....	Steel	Steel
Size of axle journal.....	4¼ by 8	4¼ by 8
Water capacity of tank.....	3,500	3,500
Frames, wood or metal.....	Wood	Wood
Brakebeams, kind and make (Nat'l hollow).....	2¼ in.	2¼ in.
Break heads and shoes, kind and make.....	Mail head	Cast iron shoe

Details of Equipment.

Guides and crossheads, type and metal.....	Two bar type iron (C. H.) guides, cast steel crosshead
Connecting rods.....	Steel, parallel rods 1 section, solid ends
Brakes.....	Westinghouse-American outside equalized
Lubricators.....	Nathan S. F.
Injectors.....	No. 10 Metropolitan
Valves.....	Three Cole Muffed, 2¼ in.



21-inch by 26-inch Ten-Wheeled Passenger Engine—Baltimore & Ohio Railroad.

Mr. HARVEY MIDDLETON, Superintendent of Motive Power.

Built by the BALDWIN LOCOMOTIVE WORKS.

Gages Two Crosby thermostatic
Springs B. L. W.
Headlights 18 in. sq.
Special devices, Compressed-air signal; Leach tandem;
Gold Steam Heating device; Gould conifer.

In the construction of all of these engines there are a number of details of interest. One feature that should not be overlooked is the manner in which the frames are braced. In engines whose boilers project through, or nearly through, the cab, the foot-plate is conspicuous by its absence, or is at best a comparatively short affair. The long foot-plate undoubtedly does much to prevent working of the frames, particularly in a longitudinal direction, and yet when the long foot-plate is omitted nothing takes its place in bracing the frames against the tendency to a racking motion of this kind. The cylinder saddles alone must resist the strain, and the mechanical department is of the opinion that herein is a partial explanation of the trouble with loose cylinder fastenings and fractured saddles. To remedy these troubles the new engines, and also such engines as go through the shops for heavy repairs, are provided with wide and heavy plates extending across the frames at some convenient point. In the new consolidation engines they are placed on top of the frames immediately back of the cylinder saddle and are 20 inches wide in the middle and 24 inches wide at the ends. They lip down over the frame inside and outside and are solidly bolted into position. In the case of some 10-wheeled engines being repaired in the shops the plates were placed across the frames at a point about midway between the cylinder saddle and firebox. Their exact location is of course a matter of convenience and clearance of other parts of the engine. Some of the new consolidations also have several heavy ribs on the outside of the saddles.

The guide-blocks on the consolidations each have three bolts, or one more than usual, making a very secure fastening. The parallel rods all have solid ends except the front ends of the front rods, where straps are used, as the cross-head would have interfered in the removal of a solid end rod.

Considerable care has been exercised in all the engines to have the cab fixtures convenient to the men, and the interiors of the cabs look very comfortable. The fireman has a steam gage for his own use, the face of which is exposed through an opening in the back of the cab. The fronts of the cabs are cast iron, from the boiler to the doors and windows.

The tanks have large filling-holes, that avoid the necessity of stopping exactly opposite a water station. The opening is 4 feet long and 1 foot wide, and is placed the long way across the tank. The water-spout can thus be at considerable of an angle and yet deliver water into the tank. There are a number of other features of the 10-wheeled engines, to which we will call attention when we publish the detail drawings.

On most roads the problem of counterbalancing engines refuses to remain settled, and if the mechanical department grapples with it, and, as they think, vanquish it, the obsequies are hardly over before its ghost appears. No matter how good the rules adopted and the precautions exercised, it seems as if some vio-

lations of the practice of the road will remain to be discovered from time to time. On this road they recently took the wheels out from under some modern passenger engines and found the axle journals smooth and apparently in good condition, but eccentric with the remainder of the axle by as much as three-sixteenths of an inch in the worst cases. The tires were also in bad shape, and upon examining the back pair of drivers they found that the builders had balanced all the revolving, and from 12 to 47 pounds more than all the reciprocating weights for those wheels. Unfortunately the main wheels had been removed from their axles by the time this discovery was made, and it is not known whether or not they were short of balance. But this is an illustration of the necessity of extreme vigilance in following out the details of counterbalancing, if correct practice is to be obtained.

The consolidation engines built for the company are of two sizes. The larger of these is shown in Fig 1, and has cylinders 22 inches by 28 inches. The smaller engines have cylinders 21 inches by 26, and resemble the larger engines so much in general appearance that we have omitted the photograph of the smaller. The smaller engines do not have the second small steam dome seen in

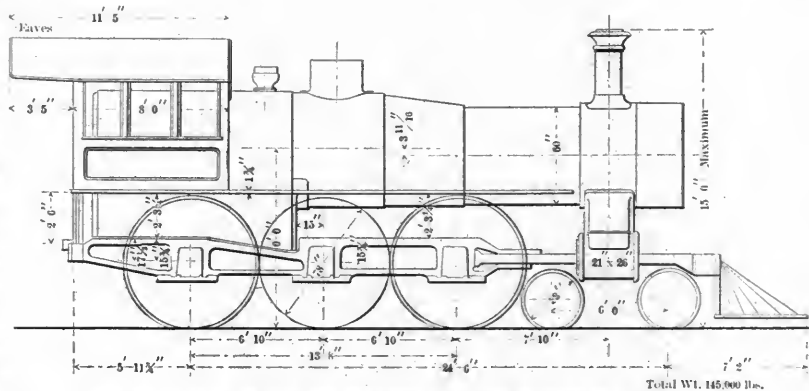
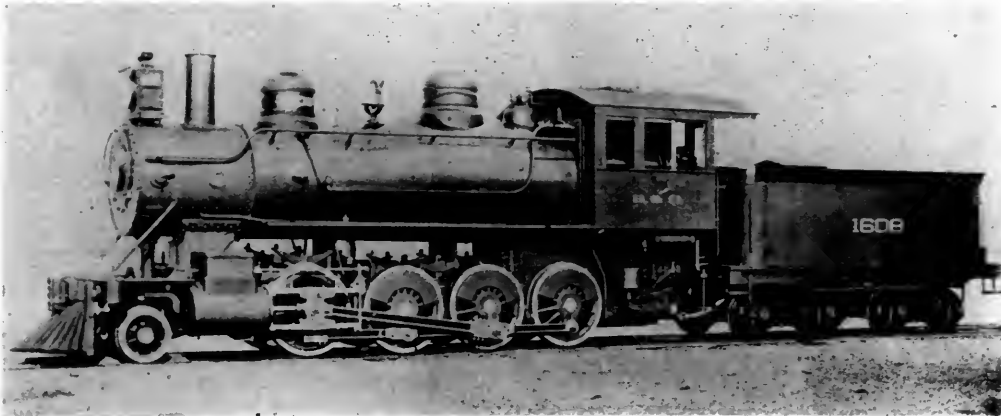


Diagram of 21 by 26-inch Ten-Wheeled Engine—Baltimore & Ohio Railroad.

Diameter of boiler at smallest ring	64 inches
Material of boiler	Park Bros., steel
Thickness of plates in boiler barrel	$\frac{3}{8}$ inches and $\frac{5}{8}$ inches
Thickness of plates in fire-box shell	$\frac{3}{8}$ and $\frac{5}{8}$ inches
Thickness of plates in sides, back and crown of firebox	$\frac{3}{8}$ and $\frac{5}{8}$ inches
Thickness of plates in front and back tube sheets	$\frac{1}{2}$ inch
Kind of horizontal seam	Butt with double welt
Kind of circumferential seams	double riveted
Material of tubes	Iron
Number of tubes	248
Outside diameter of tubes	2 $\frac{3}{4}$ inches
Length of tubes over tube sheets	14 feet 9 inches
Inside length of firebox	115 inches
Inside width of firebox	41 inches
Depth of firebox from crown to bottom of ring	67 $\frac{1}{2}$ to 69 $\frac{1}{2}$ inches
Water spaces, sides and back	3 inches



22 by 28-inch Consolidation Engine for Baltimore & Ohio Railroad—Built by the Cooke Locomotive and Machine Company.

Fig. 1, otherwise they look about the same except for the matter of size. Both classes are powerful engines, as will be seen from the following dimensions of engines built by the Cooke and Richmond companies:

22-INCH BY 28-INCH CONSOLIDATION ENGINES BUILT FOR B. & O. R.R.
BY COOKE LOCOMOTIVE AND MACHINE CO.

Type and number ordered	consolidation, 10
Total weight in working order	166,000 pounds
Total wheel base	23 feet 2 inches
Rigid wheel base	15 feet
Total wheel base of engine and tender	51 feet 7 inches
Total length of engine and tender over all	61 feet 3 inches
Diameter of cylinders	22 inches
Stroke of piston	28 inches
Size of steam ports	30 inches by 1 $\frac{1}{2}$ inches
Size of exhaust ports	20 inches by 3 $\frac{1}{4}$ inches
Greatest travel of slide valves	6 inches
Outside lap of slide valves	1 $\frac{1}{2}$ inch
Lead of slide valves in full stroke	$\frac{1}{8}$ inch
Diameter of driving wheels, outside	54 inches
Kind of truck wheels	30-inch steel-tired, wrought-iron spoke center
Size of driving axle journals	8 $\frac{1}{2}$ inches by 10 $\frac{1}{2}$ inches
Size of truck axle journals	5 inches by 8 $\frac{1}{2}$ inches
Size of main crank pin journals, main rod	6 $\frac{1}{2}$ inches by 6 inches
parallel rod	6 $\frac{1}{2}$ by 5 $\frac{1}{2}$ inches
Description of boiler	wagon top

Water spaces, front	4 inches
Water spaces, back	4 inches
Water spaces, crown bars	30 inches
Diameter of dome inside	30 inches
Steam pressure, pounds	180
Kind of grate	Rocking
Grate surface, square feet	37.75
Heating surface of firebox, square feet	182.5
Heating surface of tubes, square feet	2,153.0
Total heating surface, square feet	2,335.5
Height from top of rail to top of smokestack	11 feet 7 inches
Tires	Standard Steel Company's
Guides and crossheads	Guides steel, crossheads steel, alligator style
Connecting rods	Channeled todies
Brakes	Westinghouse; American driver brakes
Lubricators	Nathan triple
Injectors	Monitor No. 10
Valves	Richardson balanced
Gages	8 $\frac{1}{2}$ inch Crosby
Springs	Pickering
Headlight	Kelly, 18-inch, with B. & O. frame for numbers
Special devices	Coale 3-inch muffled safety valves

Tender.

Wheels	33-inch chilled
Material of wheels	Steel
Size of axle journals	$\frac{3}{4}$ inches by 5 inches
Water capacity of tank, gallons	4,000
Frames, wood or metal	Wood
Brake beams	National hollow
Brake heads and shoes	Christie

21-INCH BY 26-INCH CONSOLIDATION ENGINES, BUILT FOR B. & O.
R. R., BY RICHMOND LOCOMOTIVE WORKS.

Type and number ordered.....	Consolidation, 25
Weight on drivers.....	134,000 pounds
Weight on trucks.....	14,300 pounds
Total weight in working order.....	148,300 pounds
Total wheel base of engine.....	23 feet 2 inches
Rigid wheel base.....	15 feet 2 inches
Total wheel base of engine and tender.....	51 feet 2 inches
Total length of engine and tender over all.....	51 feet 7 inches
Diameter of cylinders.....	21 inches
Stroke of piston.....	26 inches
Kind of piston packing.....	Cast iron rings
Size of steam ports.....	18 inches by 1 1/2 inches
Size of exhaust ports.....	18 inches by 3 inches
Greatest travel of slide valves.....	5 1/2 inches
Outside lap of slide valves.....	3/4 inch
Lead of slide valves in full stroke.....	0 inches
Diameter of driving wheels, outside.....	50 inches
Kind of truck wheels.....	Standard plate, steel tired
Size of driving axle journals.....	7 1/4 inches by 9 inches
Size of truck axle journals.....	5 inches by 8 1/2 inches
Size of main crank pin journals.....	5 1/2 inches by 5 1/4 inches
Description of boiler.....	Crown bar, wagon top
Diameter of boiler at smallest ring.....	60 inches
Material of boiler.....	Steel
Thickness of plates in boiler barrel.....	7/8 inches and 1 inch
Thickness of plates in firebox shell.....	3/4 inches
Thickness of plates in sides, back and crown of firebox.....	3/4 and 1/2 inches
Thickness of plates in front and back tube sheets.....	3/4 inch
Kind of horizontal seams.....	Double riveted butt
Kind of circumferential seams.....	Double riveted lap
Material of tubes.....	Charcoal iron
Number of tubes.....	221
Outside diameter of tubes.....	2 1/4 inches
Length of tubes over tube sheets.....	13 feet 8 inches
Inside length of firebox.....	10 feet
Inside width of firebox.....	31 1/2 inches
Depth of firebox from crown sheet to bottom of mud ring.....	6 feet 10 1/4 inches front, 5 feet 11 inches back
Water spaces, sides and back.....	3 inches
Water spaces, front.....	1 1/2 inches
Crown plate stayed with.....	Crown bars
Diameter of dome.....	31 inches
Steam pressure, pounds.....	165
Kind of grate.....	Rocking bar
Grate surface, square feet.....	22.64
Heating surface of firebox.....	1,779
Heating surface of tubes, square feet.....	1,932
Total heating surface, square feet.....	3,711
Height from top of rail to top of smokestack.....	14 feet 3 1/4 inches

Tender.

Tender wheels.....	Cast-iron chilled, 33 inches diameter
Tender axle.....	Steel
Size of tender axle journals.....	4 1/4 inches by 8 inches
Water capacity of tank, gallons.....	3,500

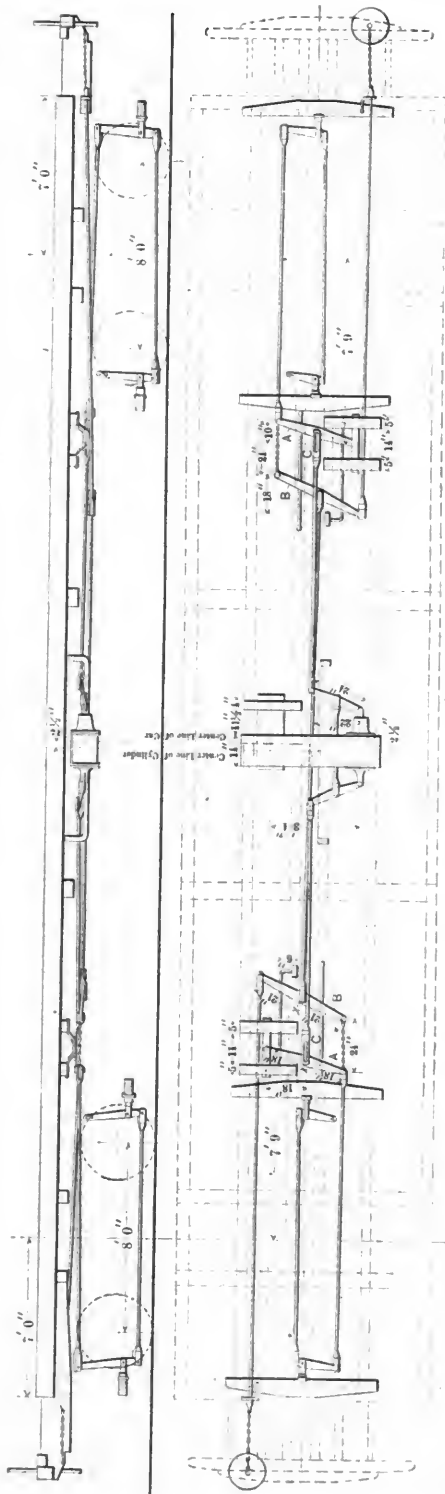
Equipment.

Tires, kind and make.....	4 flanged 4 plain, Midvale
Tender wheels, kind and make.....	Cast-iron chilled, ensign
Tender frames, wood or metal.....	White oak
Tender capacity.....	Coal, 6 tons; water, 3,500 gallons
Tender brake beams, kind and make.....	Nathan and make
Tender brake heads and shoes.....	Cast-iron Christie
Boiler.....	"Carbon" steel
Firebox.....	(Between frames) "Carbon" steel
Draft appliances.....	Adjustable dampers, brick arch, deflector and net's
Guides and crossheads, type and metal.....	Two bar steel, H-crosshead
Connecting rods, metal.....	Steel
Brakes, type.....	Westinghouse; American driver brakes
Lubricators, make.....	Nathan triple sight feed
Injectors, make.....	Monitor No. 10
Valves, make.....	Richardson balanced
Gages, make.....	A. French Spring Comps. y's
Headlight, make.....	Rochester Headlight Company, B. & O standard
Sanding device.....	Leach's sanding device
Boiler covering.....	Asbestos cement lagging

We show in the next column drawings of a brake rigging which the Baltimore & Ohio is using on some of its new passenger cars and which is now the company's standard construction. The operating department has for some time desired an improvement upon the common foundation brake, by which it would be possible to apply the hand brakes independently of the air brakes. It has been found that when a car was set out at a junction point or division terminal, it was usually switched on to the siding, and the air brakes set. This put a tension on the hand brake chain and that brake could not be set; consequently, it was left with the air brakes on, as there was no time to bleed them and set the hand brake. If the car stood for any length of time the air leaked off and the car would be in danger of being blown onto the main line or running on to it by gravity. Rules might be issued to the trainmen to prevent cars being left in this condition, but obedience to them would cause delays, and therefore the rigging shown was gotten up.

It will be noticed that the cylinder levers are connected by rods to the levers A A, and that the latter are connected to the truck levers. These are the only levers and connections needed for the air brake. The rods from the hand brakes do not connect to the levers A A, as in ordinary construction; on the contrary the ends of these levers are secured to fulcrums on the car frame.

Brake Rigging with Hand Brakes Independent of Air Brakes—Baltimore & Ohio Passenger Cars.



and the application of the air puts no strain on the brake-staffs. The levers *BB* come into service only when the hand-brakes are used. One end of each is connected to a brake-staff and the other ends are attached by chains to the levers *AA*. They are also connected to each other by a long "middle connection." The chains between *A* and *B* become slack when the air is applied, and if the hand-brakes alone are put on the slotted connections (*C*) permit the levers *AA* to move without disturbing the air-brake piston. It will readily be seen that if a car is set out on a siding and brought to rest with the air brakes, the train men can set the hand brakes in addition, and leave the car with the assurance that when the air leaks off it will still be firmly held by the hand brakes.

Car Heating by Steam.*

BY MR. R. M. DIXON.

An inquiry among those having charge of equipment on cars shows that success of steam heating is almost universal, so few troubles occur. There seems to be but few instances on any road during entire seasons, and almost all trouble can be either traced to lack of steam circulation in the train pipe, or to insufficient attention to the drips or traps. Cars cut out of trains sometimes have pipes freeze, but this is always due to neglect in opening drainage valves.

Train pipes as used for all couplers should have their ends conform to the Master Car Builders' position for direction and location. It is well to bear in mind in placing them that the tendency of the ends of cars is downward, and as the couplers, if hanging uncoupled, will almost strike the switch tracks and crossings, the end of the train pipe should be placed above rather than below the standard position. The train pipe should drain from the point where the car supply is taken off to its ends. If it cannot be done and keep the train pipe below the floor sheathing, then a first-class plan is to run it between the car sills and above the sheathing. In such a place, covering but $\frac{3}{4}$ inch thick will suffice; while if below the sheathing, covering 1 inch thick is advisable. The arrangement of the train pipe above the sheathing is standard on some roads, and it has much to recommend it.

Such train-pipe cocks should be used as are readily understood on sight. There is but little time to study out a system when a train is ready for service, and experience teaches that train-pipe cocks are the part of the equipment most difficult to understand. In service all train-pipe cocks but one, the rear one, are to be open, and in cold weather the rear one should be open enough to let just a little steam escape through it so as to maintain a circulation of steam throughout the train pipe, whether or not the rear cars are using steam.

The covering should be well applied to the train pipe; otherwise it will not stay on. Instances can be cited where the covering has remained in place but a short time, and more than one-half the train pipe become exposed and in condition to cause more condensation than all the radiating surface in the car.

As to the amount of direct steam-radiating surface in a car, experience has led to the use of two 2-inch standard iron pipes along each side. This is somewhat below what heating engineers would figure as necessary to keep the cars warm in zero weather; but as more has been found very excessive for moderate weather, a sort of compromise has resulted. The only way to satisfactorily warm cars by direct steam in all kinds of weather is to have appliances that will permit of varying the amount of radiating surface into which steam is supplied, and so approximate to a suitable heating surface to meet the conditions existing. Such an arrangement also permits of quickly heating cold cars, without overheating them when warm.

All valves and fittings placed inside of the cars should be heavy, and not liable to leak or have the bonnets come off when opening. The valves should have their use cast plainly on the handles.

For direct steam, an automatic trap for discharging the condensation is not necessary, nor desirable. The amount of condensation to be discharged after a car is warmed varies but little, and any increase or decrease of condensation is in the same direction as the change in steam pressure within the radiating pipes. Therefore, an orifice adjusted to take care of the condensation at any pressure will discharge a greater amount of condensation when there is a greater pressure to expel it.

Angle valves are usually used for drip valves, and in many cases have been so arranged as to prevent their being entirely closed. Experience has taught that it is better not to so arrange them. A very simple and safe method of adjusting the drip valves properly, given by Mr. A. M. Waitt, is to touch the hand to the drip valve, and if the hand can be borne on it and it is warm, it is all right. If it is so hot that it burns, it is too far open; and if cold, it needs to be opened a little.

With hot-water circulating systems for distributing the heat throughout the cars, the regulation of the temperature is quite easy, and the heat can be carried to various parts of the car without the multiplication of drips for the condensation that is required for direct steam.

It is desirable, in conjunction with water-circulating systems, to use some kind of a device for discharging the condensation, which device shall be in a degree automatic. The rate of condensation is quite variable, and generally the drip is located under the car, where it cannot receive close attention. If not automatic and adjusted to discharge sufficiently while heating the circulating water and raising the temperature of the car, it will be too much open after the water is hot and the car warm, and much steam will be wasted, causing not only loss of steam, but damage to car floors and varnish, as well as annoyance around the cars.

The following set of rules for handling steam equipment may be found reliable, especially if supplemented by a description of the system in use, and modified as the system may require.

RULES FOR HANDLING STEAM-HEATING EQUIPMENT—MAKING UP TRAINS.

When a train is made up, all steam hose should be coupled, and all the cocks in the steam train pipe the whole length of the train should be opened.

When signal is given, steam should be turned on at the cab, not to exceed 45 pounds, and allowed to blow through the entire length of the steam train pipe.

After steam issues at the rear end of the train pipe, the rear cock of last car should be closed, and reducing valve in cab set to 40 pounds pressure. If more than eight cars are in the train, add 5 pounds for each additional car. In very cold weather the rear train-pipe cock should be left open enough to allow a little steam to pass and escape through the rear coupling.

REGULATION OF TEMPERATURE.

To heat cars, open steam inlet valves on each car, and when live steam appears at the drips, set each drip so that a little steam escapes with the water. If a trap be used, see that it is adjusted to allow a little steam to escape with the water.

Frequently examine traps and drip valves to see that they are operating properly. They should be as hot as can be borne by the hand. If cooler, or cold, they should be opened a trifle; or if too hot, or steam is blowing, closed a little.

Never close steam inlet valves entirely without first opening drip valves or blow-off valve, and allow water to blow out before closing steam inlet valve.

When steam is required on this car again, open steam inlet valve, and afterwards close drip valves or blow-off valve.

CHANGING ENGINES.

When approaching stations where engines are to be changed, or terminals where cars are to be laid up, five minutes before arriving at such stations the rear train-pipe cock must be opened wide, and before coming to a stop at such stations the engineer must shut off steam at boiler valve. Do not use reducing valve for this purpose.

If engines are to be changed, trainmen must satisfy themselves that steam is shut off at engine before uncoupling cars.

In freezing weather, if cars are to be laid up, or stand thirty minutes after engine is uncoupled, the hose throughout the train must be uncoupled, and all drip valves or blow-off valves opened.

The greatest expense of maintenance of steam equipment is the renewal of the coupling hose. The following set of specifications and rules for testing are reasonable, and have been found to give good results. At least one per cent. of each lot of steam hose should be tested:

Samples selected at random from each invoice must deflect 5 inches for each 24-inch length for a pull of not more than any shown in the following table:

Steam at 45 pounds to 60 pounds pressure to be on hose 10 hours and off 14 hours of each day.

Maximum allowable pull to deflect 5 inches.

Before test.		During test of two weeks.	
Cold.	Hot.	Cold.	Hot.
1½-inch hose.. 45 ounces.	35 ounces.	55 ounces.	45 ounces.
1½-inch hose.. 60 ounces.	50 ounces.	75 ounces.	70 ounces.

After the test the tube must be in good condition, and the hose must not have increased in outside diameter more than 10 per cent. All hose to be smooth, uniform and well finished.

Governor Morton of New York has decided not to approve of the report of the committee recommending the adoption of the Savage gun for the State militia. He exonerates the committee from the charges brought against it by disappointed competitors and states that the report of the committee appears to be unbiased. His decision is based on the ground that the expenditure for the guns (\$300,000) is not warranted, as the United States government is contemplating arming all the militia with Springfield rifles. The Governor has also learned that there is some doubt as to a high-grade magazine rifle being necessary for such a body of troops as the State militia.

*From a paper read before the New York Railroad Club, Oct. 15, 1896.

(Established 1832.)

AMERICAN ENGINEER CAR BUILDER AND RAILROAD JOURNAL

27TH YEAR.

65TH YEAR.

PUBLISHED MONTHLY

BY

R. M. VAN ARSDALE,

MORSE BUILDING.....NEW YORK.

 M. N. FORNEY,
W. H. MARSHALL, } Editors.

R. G. CHASE, 705 Western Union Building, Chicago.

NOVEMBER, 1896.

Subscription.—\$2.00 a year for the United States and Canada; \$2.50 a year to Foreign Countries embraced in the Universal Postal Union.

EDITORIAL ANNOUNCEMENTS.

Advertisements.—Nothing will be inserted in this journal for pay, EXCEPT IN THE ADVERTISING PAGES. The reading pages will contain only such matter as we consider of interest to our readers.

Special Notice.—As the AMERICAN ENGINEER, CAR BUILDER AND RAILROAD JOURNAL is printed and ready for mailing on the last day of the month, correspondence, advertisements, etc., intended for insertion must be received not later than the 25th day of each month.

Contributions.—Articles relating to railway rolling stock construction and management and kindred topics, by those who are practically acquainted with these subjects, are specially desired. Also early notices of official changes, and additions of new equipment for the road or the shop, by purchase or construction.

To Subscribers.—The AMERICAN ENGINEER, CAR BUILDER AND RAILROAD JOURNAL is mailed regularly to every subscriber each month. Any subscriber who fails to receive his paper ought at once to notify the postmaster at the office of delivery, and in case the paper is not then obtained this office should be notified, so that the missing paper may be supplied. When a subscriber changes his address he ought to notify this office at once, so that the paper may be sent to the proper destination.

The paper may be obtained and subscriptions for it sent to the following agencies: Chicago, Post Office News Co., 217 Dearborn Street. London, Eng., Sampson Low, Marston & Co., Limited St. Dunstan's House, Fetter Lane, E. C.

CONTENTS.

ILLUSTRATED ARTICLES:	Page.
The Altoona Shops of the Pennsylvania Railroad.....	278
A Heavily Loaded Flat Car.....	286
Small Plant for Handling Coal Ashes for Locomotives, C. C. & St. L. Ry.....	287
New Equipment on the Baltimore & Ohio Railroad.....	288
A New Naptha Engine.....	291
A Device for Centering Cylinders Norfolk & Western Engine Board	302
Scrap Hopper at Schenectady Locomotive Works.....	303
Ten-Wheeled Passenger Engine for the Erie Railroad.....	309
Cast-Iron Tools.....	310
The Most Advantageous Dimensions for Locomotive Exhaust Pipes and Smoke Stacks.....	311
EDITORIALS:	
The Horseless Carriage.....	291
Preserving Notes by Photography.....	294
Contemplated Removal of the Yarrow Ship-building Plant from England.....	294
Our Crippled Navy—The Weakness of its Present Organization	295
Testing Cast-Iron Wheels.....	299
Prospect for Electricity on Steam Roads.....	300

MISCELLANEOUS:	Page.
The New Hellmuth Locomotive.....	284
The Bates Thermic Engine.....	285
Metal Cars in France.....	285
Water-Tube Boilers on French War Ships.....	286
Experiments on a Steam Engine at Liege University, Belgium.....	288
The New Torpedo Boats.....	289
Car Heating by Steam.....	292
Engineering Notes.....	303
Personals.....	305
Equipment Notes.....	306
Rotary Acceleration.....	306
European Boiler Practices.....	307
The Aylma Branch of the Canadian Pacific Operated by Electricity.....	308
Cast Iron vs. Steel-Tired Wheels	309
M. C. B. Lithographs and Drawings.....	310
Rulings of the M. C. B. Arbitration Committee.....	311
The Moskowitz System of Electric Car Lighting.....	313
New Publications.....	314
Trade Catalogues.....	314
Fourth Annual Report of the Michigan Peninsular Car Co.....	315
Granite Paint for Metal Work.....	315
Manufacturing Notes.....	315
Our Directory.....	316

A noteworthy event in the progress of the horseless carriage is announced in dispatches from London. A company operating nearly 1,000 omnibuses in that city is going, it is said, to put into service in November 100 new motor "buses," in which electricity will take the place of horses. The dispatch says that 300 more motor omnibuses will go into service in January. If this is true—we must admit we doubt it—and the selection of the style of driving machinery is wisely made, the experience gained should go far toward deciding the immediate future of the horseless carriage. If motor omnibuses can be successfully operated in the crowded streets of London, others will have faith to push the development of this type of vehicle.

The labor involved in the preservation of information contained in technical journals is serious enough to make every one who systematically files such data eager to adopt shorter and easier methods. The most novel method we have heard of is that of photographing articles of value and filing the photos. All that is necessary is to have a small camera on your desk, and when an article is to be copied the camera is turned on it, you press the button and 'tis done. This sounds well but unfortunately that is not the end. Visions of a dark room float before us, and we see an individual bending over a developing tray and occasionally cursing at a plate on which a picture will not come, or on which it is so indistinct that he can't tell whether it is that article from the AMERICAN ENGINEER which he wished particularly to save, or a page from "Trilby." This amateur photographer and veteran collector of engineering notes after spending the whole evening in the dark room finally places the good plates in a drying rack and retires to rest in the small hours of the morning. Next day he forgets about his plates and when he does think to examine them he finds most of them were not washed properly and have been ruined by "sweating." The inventory of the first 30 plates exposed reads about like this: Plates with no picture at all, 6; negatives under-developed and illegible, 11; negatives out of focus and useless, 5; plates spoiled in developing, fixing and washing, 4; good plates, 4. After studying this inventory and noting that the four good plates are the least important of the lot, our amateur photographer probably decides that running a camera is not as easy as it looks and he will return to the good old way of filing his notes.

The report that Mr. Yarrow, the well-known shipbuilder on the Thames, England, is contemplating the transfer of his business to the continent, has caused no little stir in the industrial circles of Great Britain. It appears that the labor problem has been the predominant factor in raising the question of removal. *Engineering*, in a leading editorial on the subject, says some things which workmen the world over should take to heart. We quote a few words as follows: "Workingmen are not less interested in the state of affairs revealed by Mr. Yarrow's action than are employers. How are they to protect themselves against the competition of low wages? We do not think that the remedy lies in the reduction of the rate of pay, or even in an increase of the hours of labor. What is wanted is a full recognition of the fact that a good day's work is the complement of a good day's pay. . . . If the leakage that takes place in most works could be avoided, half our commercial difficulties would disappear at once. Trade union delegates are fond of talking about the partnership of capital and labor, and therein lies the kernel of the whole matter. If the workmen would realize that out of every penny lost to the firm, three farthings comes out of their pockets, and would act on that fact, half the danger of foreign competition would be at an end. Idleness, drunkenness, inefficiency, insubordination, and the like have all to be paid for out of the 'wage fund,' and although the money comes through the master's hands, yet in the long run it is paid by the workmen." These are facts which employers should bear in mind constantly, particularly those employed in a country like this, where wages are higher than in other lands. High wages and low cost of production can only go hand in hand when the use of labor-saving machinery is supplemented by good, conscientious work on the

part of the men. Dissipation that begins Saturday night and ends Monday noon or Tuesday morning, not only causes a man's wages to rapidly disappear, but it entails loss upon his employer because of the half-filled shop on Monday, the delayed work, and the inefficiency of the man whose mental and physical powers are weakened by such a course. Equally real is the loss arising from indolence in working hours, from bad work, or the waste of supplies, etc. These losses may for a time only operate to increase the cost of the work done, but ultimately they will reduce the wages of the employee, thus placing the loss where it belongs. High wages can be maintained only by a partnership between the employer and the employee, in which the former furnishes the best of facilities in the way of plant, labor-saving devices and competent superintendence, and the employee contributes the best work possible, contributes it regularly, and adopts peaceable methods for settling disagreements between himself and his employer.

OUR CRIPPLED NAVY—WEAKNESS OF ITS PRESENT ORGANIZATION.

The growth of our new navy, as evidenced in its powerful battleships and swift cruisers, is a source of pride to the American people, and it is with much satisfaction that they contemplate the engineering skill exhibited in the design of these vessels. Unquestionably, there is good reason for much of this pride, for not only do the vessels rival those of the most advanced nations in machinery, guns and armor, and in all the essentials of efficient fighting machines, but they have been created by a nation that only a decade ago had no navy worthy of the name and whose magnificent merchant marine of 50 years previous had dwindled to insignificance.

So remarkable has been the growth of our navy that the fleet which is now the pride of the American people is the wonder of other nations. But little more than a decade of modern naval construction has sufficed to bring into prominence the work of American naval engineers and American builders and manufacturers of naval structures and materials.

Some of the greatest advances in the construction of armor are the work of American engineers and manufacturers; the ordnance on our vessels is as good as that possessed by any other nation; the engines that propel them are recognized to be of such excellence that a fleet engineer in the English navy, after saying that his nation had little or nothing to learn from foreign nations about marine machinery, added, "not even from the United States"; the boiler power given these vessels is so abundant that we hear of none of the vexatious failures common in some of the best navies, and the advantage which American men-of-war possess in their ability to run at full speed over long distances without distress to boilers or engines is recognized abroad; our battleships, while not the largest, are noted for the heavy armor and ordnance carried on their displacements; the cruisers *Columbia* and *Minneapolis* are the swiftest war vessels of their type afloat; and in the new armored cruiser *Brooklyn* the United States government possesses another vessel that leads its type in speed. Such achievements as these in a period of little more than ten years, are rightly viewed with pride, although only men like our readers, who have a technical knowledge of engineering and industrial enterprises, can fully realize the extent of the progress made.

It is so pleasant to view this side of our naval growth that it is all the more disappointing to turn our attention to another and more important part of the navy, one which is less creditable to us as a nation. We refer to its personnel. The material side of our navy, represented by its ships and their equipment, is a bright picture, but the personnel presents a picture that though brilliant and attractive in many respects is, nevertheless, sadly stained and discolored. The best interests of the navy require that this picture be studied with care. All that is grand in the modern war vessel has been given general publicity, but exceeding care has been taken that outsiders should not know how inefficient our navy would prove in time of war through the weakness of its organization. The taxpayer is given full opportunity to ascertain the qualities of the ships in which millions are in-

vested, but the fact that these millions of investment are endangered in times of peace and virtually rendered impotent in war by an organization that reduces to the smallest possible number the all-important staff of engineers, is carefully concealed from him. An efficient navy cannot exist without good ships, but neither can it exist without good men, and though both are desirable it is a fact that "good men with poor ships are better than poor men with good ships." But the citizens of this country, ignorant of the true condition of the navy personnel, are to a large extent following in the footsteps of their law-makers and have become so impressed with the ships of the navy as to ignore the necessity of an efficient and united body of officers to command them. Thirty years of comparative neglect of this the greatest source of any navy's strength, has resulted in a condition of affairs in our own navy that is dangerous to the nation and practically sets at naught its investment in ships.

THE PRESENT SITUATION.

Turn from admiration of our ships to inquire into the official personnel and regulations of the navy and what do we find? Officers who should be at peace with one another and united in their efforts to advance the efficiency and effectiveness of the navy, divided into warring camps, the smaller of these camps on the defensive and the larger bent upon the subjugation of the smaller to a condition of humiliation and degradation! We find many true and noble men in all ranks of the service, but we also find abundant evidence of the existence in the larger camp of a class or clique of officers better versed in the business of politics and intrigue than of war, busily engaged in practicing on land the arts of trickery and political wire-pulling while professing to be of the stuff from which the heroes of the sea are made, and guilty of such gross acts of oppression and injustice to their fellow-officers as to make it questionable whether they are not so utterly devoid of patriotism and manliness as to be unfitted to command either in peace or war! We find the engineer officers, the smaller of these warring camps, reduced in numbers until they are not physically able to properly perform all the duties pertaining to their offices, subjected to many petty annoyances, deprived of their rights and humiliated in the eyes of their subordinates! These engineer officers, highly educated, skilled in the sciences and applied mechanics, to whose abilities we owe the existence of our new navy, and without whose services it could not be maintained or its ships operated for a single day, treated by line officers as if they were merely uneducated engine drivers! Line officers can be found assigned to duties for which they are wholly incapacitated by training and education, and drawing salaries for which they give no adequate return to the nation! And the entire service weakened by the intrigues of men who have taken unto themselves powers which are vested in the people and the legislators they have elected, and are using those powers to limit the usefulness of better men than themselves, and to prevent the enlargement and improvement of the engineering branch of the service!

We are perfectly aware that these are severe words, and they would never have been written if there was any hope that reform could come from within the navy; but there is no such hope, and the treatment which the clique of line officers see fit to accord to the engineer officers—and to other line officers who will not bow to them—is so despicable in itself, so unjust to a loyal and honorable branch of the navy, and so injurious to the service, that it calls for action on the part of those who love their country and desire fair treatment for those who serve it, even if a condition of affairs is made public that is humiliating. Our readers have read something of these troubles in the pages of this and other journals, and we trust they will join in the protests that are now coming from many sources, and use their influence to bring about a better state of affairs. They can do this through their Congressmen and through the engineering societies and other organizations of which they are members.

The Wilson-Squire bill, presented before Congress last Spring, will come up again in the next session. It provides remedies for the worst evils in the present organization of the navy personnel, and every section of it can be safely endorsed. Are the thousands of men in the engineering profession in civil life

going to lend their influence to bring about a more efficient organization, and to righting the wrongs of their brother engineers in the navy, or must the naval engineers fight unaided the battle that has been forced upon them by the line officers?

THE STRENGTH OF THE ENGINEER CORPS.

The present condition of affairs is traceable to the introduction of steam propelling power and machinery on board of the modern man-of-war, and to understand the situation it is necessary to go back over a period, which, though short, witnessed prodigious changes in naval construction and warfare. In 1839, or only 57 years ago, the United States did not possess a single war vessel propelled by steam. The commanding officers at that time if skilled in seamanship, navigation and gunnery, possessed all the technical knowledge necessary in their positions. Their successors of the present day constitute what is known as "the line." In 1839 Congress authorized the construction of the first United States war vessel fitted with propelling engines. This boat was the *Princeton*, built upon the plans of Captain John Ericsson.

In the same year the construction of two other steamers was authorized, and as there was no established corps of engineers in the navy to design and construct the necessary machinery, the Navy Department appointed the late Charles W. Copeland to superintend this work with the title of "Principal Engineer." With the steam engine came the specialist; engineers had to be obtained to run the engines. It is perhaps not surprising under the circumstances that the engineers should be only warrant officers and were below carpenters and sailmakers in rank, for the importance of the steam propelling machinery was not then realized.

Steam power on war vessels had come to stay, however, and, in 1861, at the opening of the Civil War, the government had in commission 52 sailing ships and 37 steam ships. Comparatively simple and small as was the machinery on board these 37 boats, we find there were 174 naval engineers in the service, while the line officers numbered 671 for the 89 ships of steam and sail.

With the exception of the six years immediately preceding the war nothing had occurred in this period to change the status of the engineers or to make Congress and the country realize the important part they were to play in future naval operations. But during these six years the boiler and engine power in new vessels was increased considerably and there had entered the service a corps of very strong men, nearly all graduates of the Rensselaer Polytechnic Institute. In fact, we had vessels like the *Minnesota* and *Merrimac*, superior to anything possessed by other nations. The status of the engineer had improved to the extent that he was now given "assimilated rank." What fine shade of meaning was conveyed by that term it is difficult to comprehend, but it gave the engineers no power to command and they were considered as non-combatants. We have also seen that in numbers the corps was very small. But the Civil War opened the eyes of every one in the navy to the importance and value of their services, and the needs of the navy compelled a great relative increase in the number of engineers as compared with line officers. The ratio between the two was changed materially. Thus, in 1864, or when the Civil War had placed the navy upon a fighting basis, there were 2,846 line officers and 1,728 engineers, regular and volunteer, in the service. There were in all 617 vessels, steam and sail, and if the sailing vessels are thrown out of consideration there were more engineers than deck officers for the steam vessels. In 1865 the numbers had risen to 2,463 line officers and 2,379 engineers.

In 1866, when the navy had been placed on a peace footing, there were 395 line officers and 379 engineers, thus showing that while in war the force of engineers was of necessity almost as great as that of the line, in times of peace with the experiences of a late war vividly before everybody, the need of an efficient corps of engineers was recognized, and practically the same ratio between the numbers of line and engineer officers maintained as had existed in the war. In that year there were 320 vessels in the navy register, the largest of 5,090 tons (old measurement) and the smallest of 50 tons (old measurement), and though the displacements of all the vessels are not on record, the 121 whose records

are available show an aggregate tonnage of 119,561, or an average of less than 1,000 tons. The exact horse-powers are not known, but they averaged from one-quarter to one-third of the displacement, or say about 300 horse-power per vessel. A little calculation will show that the number of line officers was one for about each 800 tons displacement, and that the engineers each looked out for about 300 horse-power of machinery.

The importance of the engineer was now so evident that an intense jealousy sprang up in the line against them, and every means available was employed to keep them down. The result of this jealousy of the line is seen in the naval register of Jan. 1, 1886, just before the first vessel of the new navy went into commission. Then we had only 73 steam vessels, which included serviceable vessels, those requiring extensive repairs and others launched but awaiting appropriation to complete them. This number also included 13 tugs, one or two of them useless, and others of but little efficiency. In addition to the steam vessels we had 12 wooden sailing vessels. The displacement of the 73 steam vessels was 132,075 tons. The tonnage of the 12 sailing vessels was 23,586. With the exception of a few vessels which were built of iron, the horse-power of the several ships was about what it was in 1866, since we possessed at that time practically the remnants of the war navy. But on this same date, Jan. 1, 1886, the register shows that we had 733 line officers, and only 221 naval engineers in the service! Eighty-five vessels, 13 of which were steam tugs, and 733 line officers! One line officer for each 212 tons displacement, as against 800 tons 20 years previous! It should be borne in mind that during all this period engines were auxiliary to sails, and the ordinance had not changed materially, so that the duties of line officers required practically the same knowledge as in the beginning of this period. Why, then, this enormous increase in numbers and the decrease in the number of engineers?

Then came the new navy with its absence of sails, its great steel ships, enormous propelling engines, high-power guns and complicated machinery. Our readers need not be told that it is an engineer's work to design all the machinery of such vessels, and to care for and operate that machinery in service. But on Jan. 1, 1896, we had 168 vessels in commission, aggregating 285,466 tons displacement and 317,275 horse-power, 714 line officers and only 173 engineers, or one less engineer than just before the war, when there were only 37 steam ships in commission and not one of them with engines of more than 1,000 horse-power—and less than one-half as many as in 1866. And yet in this period the number of line officers were nearly doubled.

Nor has the status of the engineer improved much during this period. Congress tried to give him the much-needed rank and authority in 1871, but the line had the word "relative" inserted in the bill before the word "rank." This was objected to by several members of Congress, but upon receiving assurances on the floors of both Houses that the word would not abridge the rights and authority of the engineers, it was allowed to remain in the bill that became a law. Once a law, the line snapped their fingers in the faces of the engineers and told them that relative rank was no rank, and that the Congress which had meant to do so much had actually done nothing. This shows the power of being able to interpret a law—a prerogative which is the province of the judiciary, but which has been seized by the sailor officers.

This brief sketch throws a little light on some of the doings which have brought the naval forces to their present status. Loath as one may be to believe that a "machine" exists, does anyone suppose that without undue and baneful influences at work the creation of a new navy of steel ships, involving the highest knowledge of steel construction, steam engineering, electric and hydraulic engineering—all the province of the engineer—would be accompanied by a great increase in a branch of the service that has a superficial, if any, knowledge of these matters, and a decrease in the branch that is expert in them? We might go into many details to show that improper influences have been and are at work, and that the great increase of the line and decrease of the engineer corps was not the result of natural causes, but due to a pernicious activity of a por-

tion of the line, but we deem it more important at this time to exhibit the present weakness of our navy and to state the changes necessary to remove that weakness than to show up the clique that has brought about the existing conditions. Besides, in exposing the weakness of the navy we incidentally air the methods of the "machine."

THE ENGINEERS OVERWORKED.

There are many evidences at hand that the engineer officers are overworked and the safety and efficiency of our magnificent fleet endangered thereby. We have already shown how their ranks have been steadily depleted as the number of modern vessels has increased—a fact which is proof enough in itself. Furthermore, members of the engineer corps are constantly breaking down in health in the discharge of their duties at sea. We can recall many cases already this year, and if we went back over the records the list would be a most formidable one. In our September issue we recorded the breaking down of two engineers on the *Indiana* or one-half of the engineer force on a \$5,000,000 ship. A few days ago two engineers on the Asiatic squadron broke down, leaving this squadron on the other side of the globe with a force of 10 engineers only. The reasons for these breakdowns are easy to be found. A vessel goes to sea with such a small complement of engineers that these officials have sometimes to take watches for 12 out of each 24 hours. The vessel has so many line officers on board that these men have known to be on duty only four out of 24 hours. The engineers have direct charge of one or two millions' worth of machinery below decks, and they and their men are working in a temperature of from 150 degrees to 170 degrees. The deck officers navigate the boat and have charge of the men who scrub decks, polish the bright work, and do police duty, and they perform these onerous duties in the fresh, bracing air. Is it any wonder that the engineers break down and that the breaking down of a line officer is unheard of? Chief Engineer Tower, of the *Indiana*, had been on duty continuously for 36 hours when he succumbed to the strain.

To show how short-handed is the engineer force on some of the boats in which the taxpayers have invested millions, let us make a few comparisons. The *Minneapolis*, a 23-knot triple-screw cruiser, 7,375 tons displacement and 21,000 horse-power has 90 separate engines, with a total of 172 steam cylinders. She has at present three engineers and three cadets under instruction. She is supposed to have four engineers, but one of the engineers on the European station recently broke down, and now they are short-handed. The American line steamer *St. Louis* of 16,000 tons displacement has about 20,000 horse-power. We don't know how many separate steam engines are on board, but evidently they are less than on the man-of-war. She has four senior engineers, 15 junior engineers, 2 electric engineers, 2 refrigerating engineers and 1 deck engineer, or a total of 24, to say nothing of 6 cadets.

On the *St. Louis* we find no grade between engineers and the oilers and firemen except two storekeepers. On the *Minneapolis* there are supposed to be six chief machinists at \$70 per month, six first-class machinists at \$55 and five second-class machinists at \$40 per month. When we consider that a man-of-war must be in a large measure independent of docks and repair stations we might well look on these machinists as the repair gang. The chief machinists are supposed, however, to be capable of taking an engine-room watch. The first-class machinists need be only machinists with some knowledge of marine engines and boilers, while the second-class machinists need have no experience at sea whatever, with marine engines. Evidently, if there were six chief machinists capable of standing a watch the situation would still be pretty bad. But so inadequate is the pay and so galling the service in the engine and fire rooms of our men-of-war that the government cannot get men to enlist as chief machinists in sufficient numbers. Men intelligent enough to be trusted alone on an engine-room watch can get better pay on shore. And on shore they don't have to sleep in hammocks spaced in some cases only 13 inches from center to center, and to turn out in the early morning with the deck hands after working nearly all night on repairs or other emergency work. On the *St. Louis* all

the junior engineers have bunks and can have undisturbed rest after such duties. It is not so with the chief machinists. What is the result of all this? On the *Minneapolis* there is only one chief machinist! There are 11 first-class and 1 second-class machinist on board. Consequently where the *St. Louis* has an entire engineer force of 30, including cadets, the *Minneapolis* has three engineers and one machinist capable of taking a watch, and three cadets not yet graduated from school, or a total of seven persons, only three of which are worthy of the title of engineers, and really ought to be trusted implicitly with the care of the machinery. On the *Minneapolis*, now in the Mediterranean, the Chief Engineer is probably taking a watch of four hours himself, besides attending to his duties in connection with the supervision of the entire engineering force, the other engineers and the chief machinist are on duty 10 hours out of the 24, and what these men can't oversee of this immense engine, boiler and machine plant, worth more than \$1,500,000, is of necessity intrusted to machinists paid \$55 or \$40 per month!

Another startling condition of affairs is found in the firerooms. These are in the immediate charge of the water tenders paid \$40 per month. It must be borne in mind that these boilers are in several compartments separated by bulkheads in which all doors are closed when the ship is underway. Here are, say, 21,000 horse-power of steam generators with feed pumps, ash hoists, bilge pumps, etc., etc., under the charge of \$40 per month men. The engineers on watch can give but little attention to the fire room with their present numbers. The line believe that there should be a commissioned officer on deck for every small gun carried. Why should there not be a commissioned engineer officer at all times in every one of the six compartments containing the propelling machinery? Would not the safety of the vessel be promoted thereby and the expense of maintaining its machinery be reduced by such complete and intelligent supervision? The highest naval authorities are agreed that the salaries of these additional officers would be more than saved by the reduced repairs. We would point out that these additional salaries in the engineer staff could be provided for by reducing the number of line officers, of which the *Minneapolis* carries nine, besides four cadets.

It is proper to note that the pay of machinists in the navy and their duties are decided, not by the engineer officers, but by the Bureau of Navigation. To read the schedule of pay and duties will convince any intelligent reader that they were never prepared by men familiar with the requirements of the engine room force on board ship.

In the British navy there are 1,739 line officers and 795 engineers—a ratio of 2.18 to 1. In our navy, as already stated, there are 714 line officers and 173 engineers—a ratio of 4.13 to 1. Thus we have relatively only one-half as many engineers as in the English navy; and it should be borne in mind that great pressure is now being exerted in favor of an increase in the number of English naval engineers because of the inadequacy of the present force.

If any further testimony of the overworked condition of the engineers is needed it can be found in the report of the Surgeon-General of the Navy for 1895, where he calls attention to this fact in words that leave no room for doubt.

EXCESSIVE NUMBER OF THE LINE OFFICERS.

There is, therefore, no escape from the conclusion that the engineer corps is in numbers far below what is necessary to operate and properly maintain our ships. The zeal and ability of the 173 on whom the duties fall have prevented until recently a full realization of the actual situation. But though the engineer corps is so small as to make it impossible to perform certain shore duties in connection with the building of new vessels and the repairs of old ones, there is no shortage in the "line." Out of a total of 714 officers, there were, Jan. 1, 1896, only 338 attached to vessels at sea. Of the 376 on shore, 91 were on duty at Washington; nine were running a war college that holds sessions in the summer months only, and whose average attendance is about 25; 51 officers were running a naval academy at which there are only 241 cadets in attendance; at Newport there are, in addition

to the 9 officers at the war college, 12 at the training ship and torpedo station, but not one engineer; at the Boston Navy Yard there are 8 line officers and only 2 engineers; at Mare Island there are at the receiving ship and navy yard 13 line officers and 7 engineers; at New York there are altogether 23 line officers and 17 engineers. But perhaps the inspection of steel furnishes the most surprising examples of the employment of line officers to the exclusion of engineers. The steel board is composed of two line officers and one engineer. The inspection of steel and armor is performed by 6 line officers, 2 engineers, 1 carpenter and 2 sailmakers! The inspection for the Bureau of Ordnance is done by 6 line officers. So that out of the 20 officials concerned in the steel inspection there are 3 engineer officers, or the same representation as is given the carpenters and sailmakers! Is any comment necessary?

THE STATUS OF THE ENGINEER.

Essential to the efficiency of the service as is an increase in the number of engineer officers, a better official status which will make the organization attractive to scientific experts is equally so. At present, the naval engineer is denominated a civil officer, although exposed to as great danger as the man protected by the walls of the conning tower. He is termed an "adjunct," "auxiliary," "noncombatant," and the watch bills of some of our warships will show that he is also officially designated as an "idler." He is given what is termed "relative" rank, but when the fact is comprehended that he is not officially regarded as a military officer it is unnecessary to state how discredited and unsatisfactory the possession of relative rank is. By reason of not possessing military rank he is subject to the beck and call of numerous underlings claiming to be invested with the prerogatives of the commander. As Professor Hollis has epigrammatically said, the conferring of relative rank simply permits the Department "to fix precedence so that there be no dispute about the order in which officers select their rooms on board ships, march in funeral processions, approach and bow before the President at a New Year's reception, or sign their names on official papers."

The status of the naval engineer will not be properly recognized until he is given absolute military rank, for the line have never recognized the possession of relative rank by the engineers as giving the corps a military status in the service. The spirit of this contention has been expressed by one line advocate in these words: "Equality with line officers is simply absurd. You may depend upon it that any amount of money and political influence will be forthcoming at the proper time, if necessary, to resist the unparalleled impudence and assumption of the subordinate branch of the navy to the honors and dignities of the line."

The engineer officer on board ship thus finds himself in a discredited position, where he is unable to carry on his work to the best interest of the nation. He is nominally "in charge" of the entire engine-room and fire room force, but a deck officer who is his junior may assume prerogatives which will demoralize and disintegrate an organization which the engineer has been perfecting for months. Even when the commander is within speaking distance of the officer of the deck the subordinate line officer claims to be in charge of the ship, and the line even goes so far as to maintain that the naval cadet who is on probation when temporarily in charge of the deck can presume to assert such authority over the engineer and his department. A fitting finale to such an organization is a corps of prostrated engineers, a fleet of ships which are inefficient, and a service that is badly crippled for the work of war. Surely its weakness only needs to be pointed out to have Congress effect radical reform.

It is not surprising that with a powerful "machine" in existence, and with the engineer corps without proper status, justice should miscarry in many courts-martial, the favorites being protected and others unduly punished. Mr. Mattice, formerly of the naval service and now a distinguished consulting engineer, gives a summary of many courts-martial; we cannot go into the figures at length,* but the navy records show that two trials of line officers for cowardice resulted in the offenders receiving sentences aggregating

three years of suspension, and a total loss of six months' pay; of twelve cases where ships were lost apparently through the fault of line officers, seven cases were never brought to trial, and in four cases the suspensions aggregated 9½ years, or an average of only 14½ months for each officer implicated, all suspended officers being paid from three-fourths to full pay during the periods of their punishments, while in the twelfth case the commander was dismissed from the service, as it was shown that he was intoxicated at the time his vessel was lost; in six cases of vessels aground, four were never tried and the other two resulted in nine and ten months' suspensions respectively for the captains; a serious damage to a ship in docking was punished by six months' suspension of a line officer; drunkenness on duty, two months' suspension. In all of these cases the parties were in the pay of the government during the suspension, often under full pay, except where we have noticed to the contrary. But a past assistant engineer a year or more ago was tried for being absent without leave while his ship was tied to the wharf of a navy yard and he was sentenced to one year's suspension on furlough pay (one-half of "waiting orders" pay) and to lose all promotions in that period, which resulted in his losing ten numbers on the list in his grade. Other cases of equal discrimination could be cited. Admirals too honorable to toady to the "machine" and secretaries of the navy have remonstrated in vain at the inadequacy of the punishments meted out to line officers and have set aside as perversions of justice many of the sentences against engineers. The daily papers recorded such a case only last month. Any intelligent person can realize that such discrimination between line and staff officers fosters a spirit of bitterness between officers and men alike, and that the unjust treatment of engineers in courts-martial and in all matters involving authority and discipline is resented by the entire engine and fire room force of enlisted men. These men are often badly treated themselves by the deck officers and they know by bitter experience their own officers are helpless and that they can turn to no one who understands them and their work.

Shore duties also furnish several good illustrations of the evils arising from this lack of authority in the engineers, one of which is found in the inspection of steel already noted. If any private concern bought hundreds of tons of steel at a cost of \$500 per ton it would exercise every care to see that the material was properly inspected, but the armor for the navy is inspected by line officers who certainly cannot be expected to know as much about steel as the engineer. How was it possible for the armor frauds of several years ago to be perpetrated upon the government if the inspectors were capable? Why were these frauds hushed up? Would they have been hushed up if the inspectors had been engineer officers? As another illustration, turn to our navy-yards and arsenals. Here we find these great building and repair establishments under the control of line officers and so firmly in the grip of military rule as to make the time required and the cost of the work done by them much greater than the best authorities believe would be required under a supervision of trained engineers. Would any private manufacturing establishment place millions of capital and a working force whose pay roll aggregates many tens of thousands per month under the control of men not trained in engineering or of engineers with limited authority?

Even the design of our ships are not free from these influences. Some of our great battleships might be faster than they are if the bureaus of steam engineering and construction could get an unprejudiced hearing for their opinions. The electric plants on these vessels have been taken from the control of the engineers and operated by the line until they break down, when the former are sent for to repair them. These plants must now be located to suit the convenience of the line officers, regardless of whether such locations are the best. Nay, more: the steam pipe running to the dynamo engines must not take steam from any steam main, but must tap the boiler itself. An extra hole must be made in the boiler and a hundred feet of extra steam piping, more or less, must be provided to give to the electric plant of the "line" the necessary isolation from the domain of the engine-drivers! The naval attaches in foreign countries are maintained

* We would refer our readers to Mr. Mattice's open letter, "Queer Doings in the Navy," and to a valuable article by Mr. Wm. Ledyard Cathcart in *Cassier's Magazine* for October.

in those positions chiefly for the engineering information they can pick up for the department at home. Of course they are engineers. Nothing of the kind. They are line officers without training for such duties. The country no doubt will be amazed to learn that the education of these line officers, preparing them for the most desirable duty of naval attaché abroad, is accomplished in 10 or 14 days. Previous to taking their departure for Europe to perform the engineering duties required of a naval attaché, they receive a roving commission to visit the largest engineering establishments in this country. The very fact that they undertake to study American methods in 10 or 14 days shows their absolute incompetency for the work. The only advantage they derive from this tour of inspection is that they receive eight cents a mile while making a pleasant excursion at the expense of Uncle Sam.

It was through one of these brilliant attachés that the government spent a large sum for the purchase of plans in England for the *Charleston*. In a discussion before the Engineering Congress at the World's Fair, Mr. Mattice gave some information about these plans that shows how competent was the attaché. The plans were supposed to be those of the *Naniwa-Kan*, but the general plans were those of the *Etna*, and the details were of the *Naniwa-Kan* and *Giovanni Bausan*, "and there were one or two of a rather chestnutty flavor that would not fit in with anything else." The Secretary of the Navy ordered these plans to be followed closely, and as a result costly changes had to be made as the work progressed, and the vacuum pumps had to be discarded and new ones built at a cost to the government of \$50,000. Another set of plans purchased in England were not quite so bad, but many changes were made in them by the bureau of steam engineering and construction before the *Baltimore* was built from them.

THE OPPOSITION OF THE "MACHINE."

The machine fights tooth and nail the proposition to improve the number and status of the engineers, and insists that any increased authority given them will demoralize the service. They charge the engineers with a desire to get everything in their power. As this article is in course of preparation, there comes to our desk a copy of the *Army and Navy Journal* for Oct. 3, containing an article written by a line officer. In this article he says: "The engineer feels that since modern vessels depend entirely upon steam for ability to use their guns, and since engines depend on trained knowledge, and since he must undergo danger without the line officer's privilege of striking back, *he should have the best of everything*. It is suggested that the naval engineer is on a plane with the scientific army engineer, and it is proposed to *make the naval engineer the leading officer of the navy*. They forget that their basis is engine-drivers." The italics are ours. The supposed claims they emphasize are fictitious and false. The engineer does not ask for the command of vessels, but he does believe that the good of the service and his own honor alike demand that he be under the authority of the commanding officer of the vessel and not at the beck and call of every officer of the deck, even an ensign. He does believe that the good of his branch of the service demands that his present "relative rank," which is title without authority, be changed to a positive rank by which his titles will mean something. He does believe that the deception now practised upon the people of the nation, by which engineer officers appear in civil life and on state occasions with the honors of their titles, but on board ship are stripped of it all, is a farce that endangers discipline and engenders discontent and strife among the entire crew.

But the line officer we have quoted above is really anxious about the engineer. Hear him again: "The engineers want too much, but that is no reason why they should not have justice. *Let us do justice.*" Need we go any further for evidences of a clique? Has it come to this that the line officers announce to this nation that through the line, if at all, justice is to be meted out to the engineers? We admit that proposed changes in the navy affecting the authority of officers might properly originate with the line in which the right of supreme command is vested, but there is little hope that they will. We quote again: "The

line is the corps of command, and must be. Nothing the engineers may do can alter that. . . . When the engineers recognize that command is essential and must go to the line, then it will be possible to institute a new plan that will give them justice. If they can once see that *the corps of command is the navy*, a reform can be made that will give them a share of the honors of war. I suspect that the real bitterness of the engineer's fight has lain in the feeling that he belonged to a body of men who are expected to do the dirty work, accept danger in the dark and get none of the credit of success."

The corps of command is the navy! This is on a par with the insolence of the line officer who told an engineer that he (the engineer) was in the navy but not of the navy. The engineers, a body of men who are "expected to do the dirty work, accept danger in the dark and get none of the credit of success"? Who expects them to do this? The line officers may, but does the nation? The real bitterness of the engineers' fight has lain in the fact that he knew the nation thought he was getting his due credit, whereas it was being systematically withheld from him. But the last quotation relieves us of the necessity of proving that engineers are unjustly treated under the present order of things, for this line officer expressly admits that they are.

HOW A NAVAL RESERVE CAN BE OBTAINED.

Then both justice and the immediate needs of the service make it imperative that the engineer corps be increased in numbers and that the engineers be given rank equal to their confreres in the line and an authority that will make that rank respected. But another and an equally good reason exists for raising the status of the engineer. If the number of engineers is to be increased and an adequate reserve is ever to be provided for the time of war, inducements must be offered to get men for the service. They will not enter it in sufficient numbers under the present conditions. The engineers already in the navy would resign from it with little delay, did not loyalty to their country and the hope of finally receiving justice from her hand keep them in her service. Even as it is resignations have been numerous, and the number of engineers graduating annually from the naval academy is not sufficient to balance the loss from breakdowns, deaths and other causes. If honorable positions in the navy are with in the reach of graduates of our technical schools and colleges, many will avail themselves of the opportunity—but not until the engineer is accorded justice. And if war should ever come, ex-naval engineers and others in private life will not offer their services to their country—where such services involve a degradation. It may be argued that loyalty should bring the engineers into their country's service in time of dire need, regardless of questions of rank and title. It should not be forgotten, however, that the greatest of patriots are always the manliest of men, and that a nation which wants the services of noble men in time of war should not neglect the present opportunity to make that service an honorable one.

The engineering profession of the United States have pointed out the naval weakness to Congress and the people, but they have done more than that—they have shown what remedies should be applied. The Wilson-Squire bill, already mentioned, introduced in the House by the Hon. Francis H. Wilson, of Brooklyn, N. Y., should be the basis for all naval legislation enacted for the personnel. If the engineering profession will continue to display its interest in this bill, Congress can be made to realize the crippled condition of the navy, and the bill thus become a law.

TESTING CAST-IRON CAR WHEELS.

In one of the earlier articles on the Altoona shops, which appeared in these pages, an account was given of a method of testing car wheels by pouring molten cast-iron around the treads, the wheels being laid in the mold with their backs or flanges down. As was then described, a sand mold is made around the tread of the wheel which leaves a space of about 2 inches wide between the sand and the tread. Melted iron is then poured into this space. Most of the wheels that have been tested in this way, it was found, broke or cracked in from 25 seconds to 1 1/2 minutes from the time the metal was poured. The inference from this was that if wheels are broken by heating them in this

way they will also be broken by the heating action of brake-shoes when these are applied, especially at high speeds.

It may be said here, incidentally, that mankind may be roughly divided into two classes, one composed of people disposed to entertain new ideas, and the other of those who are not, many of whom have a positive disinclination to give consideration to any subject, or credence to any facts, or accept any process of reasoning, of a kind with which they are not familiar. Many such people, too, are born objectors, and are possessed of a wonderful capacity for finding reasons why things are not so. They are like the lawyer who was consulted in that well-known case of the prisoner who was incarcerated for a certain offense, and who was told by his legal adviser that a person could not be put in jail for the act of which the prisoner had been guilty. "But I am locked up," the client pleaded, but that fact would not change the opinion of the lawyer.

With the class of people referred to facts have no more weight than the lawyer was willing to assign to the curtailment of his client's liberty. It is in vain, in arguing with such people, to bring incontrovertible evidence to establish certain facts. They are deficient in the capacity of believing, which the Scriptures teach is a means of salvation and assure us that neither would such people believe although one rose from the dead.

This digression was suggested by the way in which the account of the thermal tests of wheels at Altoona, which was published in these pages some months ago, was received by some of the readers of the AMERICAN ENGINEER, CAR BUILDER AND RAILROAD JOURNAL. One correspondent said the test was "sensational." Others said it was not new and some of the wheel-makers thought it was not fair. All admitted that car-wheels are often heated by the application of brakes, but then they say they do not get "so very hot," or they are not heated so quickly by the brake-shoes as they are by the melted iron poured around them. Now as a matter of fact no one knows with any degree of certainty how hot a wheel gets when brakes are applied on a car. One case is reported of a wheel, broken in service, which was so hot an hour after the accident that it could not be touched without burning the toucher. Imagination only can infer how hot it was when broken. As a matter of fact wheels are not "very hot" when they break under a thermal test. They often crack within 25 seconds or less time after the pouring of the metal. Not a very high degree of heat can be transferred to a wheel in that time. Who knows how quickly or to what degree a wheel will be heated if an "emergency" application of the brakes is made when running at the rate of 60 or 70 miles per hour?

Another resource of the doubters is that any innovation in their experience or practice is not new. Even if it is not, the utility of it is not affected thereby. Would a reasonable human being object to using any useful information, even if it was exhumed from the catacombs, or dug up from the foundations of the pyramids, and was as old as Egyptian civilization. Wisdom and knowledge don't deteriorate by age if they are really either wise or true.

Some of our readers who are inclined to *dubiosity*—if there is such a word—say that the thermal test is not a practically fair one, and is calculated to unduly alarm the traveling public. Nevertheless, the Pennsylvania Railroad officials at Altoona have been developing the test, and have reached the conclusion that in specifications for wheels which they buy that a certain number in each lot received shall be subjected to a test of this kind, and if they do not stand it all are to be condemned. An extensive series of investigations were made before this conclusion was reached. More than 200 wheels were tested, of which a large proportion—about nine-tenths—were broken or cracked. The fractures were very curious. In a large number they occurred just inside of the rim and extended circumferentially for a distance varying from a fifth to a third of the way around. In some cases the wheel was merely cracked, the fracture not extending through the rim, but in others the rim was broken radially to the circumferential crack, and a piece was entirely detached from the body of the wheel. In others the break would be on a line approximating to a chord drawn to the periphery of the rim or tread. Another form

of break was on a circumferential line, about half way between the hub and rim, or where the double plates join the single one outside of them. (Nearly all the wheels tested were of the Washburn, so called, double plate pattern.) These cracks also extended from a fifth to a third of the way around, and were sometimes confined to a circumferential line and in others would extend radially from one or both ends out to or through the rim. In some instances these fractures were mere cracks, while in others a piece was bodily detached from the wheel. Often the break occurred before the molten iron had solidified, and with such violence that it was scattered out of the mold in a way that was dangerous to the bystanders. Another curious phenomenon was the fact that often a secondary fracture would occur after the first one and on the opposite side of the wheel. The two would not always occur at the same part of the wheel section nor in the same form. Some or all of the brackets or ribs were broken in nearly or quite all the tests even when the plates were not fractured. Mr. McLean, the superintendent of the foundry, who made these tests, obtained five double-plate wheels of the old pattern made by the Lobdell Company in Wilmington, Del. What is called the Washburn double-plate wheel, which is the pattern now in general use, has not in reality double plates, as the two plates extend only about half way from the hub toward the rim, and there they unite in one plate which extends to the rim. The Lobdell however, has two full plates, which extend all the way from the hub to the rim with a space of from about 4 to 6 inches in width between them. The plates are slightly curved. None of these wheels broke into pieces; several of the outside plates developed short circumferential cracks, which did not destroy the integrity or the wholeness of the wheel, and it was only the outside plate which was fractured. Altogether they stood better than any other form that was subjected to the test. It would be curious if it should be found advisable to revert to this old pattern of wheel, which was abandoned twenty-five years ago or more—or to something similar to it. This form is to be subjected to a thorough series of tests to ascertain what its real merits are.

Another fact which was ascertained was that wheels which had been in service, or second-hand wheels, did not stand the test as well as new ones. This is contrary to Mr. Outerbridge's theory that cast iron grows stronger if subjected to frequent concussions. Of course it may be that the endurance of these double-plate wheels was due to the quality of the metal in them. It is intended in the investigation which will be made to ascertain how they will act if made of the same material as the wheels which fail. Altogether the Altoona wheels have stood the tests better than any others, excepting the double-plate Lobdell pattern. Some of the Altoona wheels were broken, but many of them stood the test without fracture. It is proposed hereafter to take three wheels from every hundred, and subject one to a drop test and two to a thermal test by making a mould 1½ inches wide around the tread and then pouring iron into it, these wheels to stand two minutes without breaking. The time and the space may possibly be modified if experience shows that it is essential. The adoption of these requirements is quite certain to lead to efforts on the part of wheel-makers to devise forms which will resist thermal strains more successfully than the so-called double-plate Washburn pattern will or does. It may be added that although nearly all the wheels tested were of that pattern, their forms, and especially that of the sets or brackets, varied considerably. The forms of this pattern of wheel which were tested seemed to have little influence in their capacity to resist the expansion of their treads by heat. As was pointed out in these pages before, the strain required to fracture a wheel, even if made of poor material, must be enormous. The area of the fractured section was often as much as 25 square inches. The force required to pull this asunder can readily be calculated. The new requirement of the Pennsylvania Railroad is likely to mark a new era in the manufacture of cast-iron wheels and must lead the makers either to use better material in them or devise new forms which will resist the new test, even if made of inferior iron.

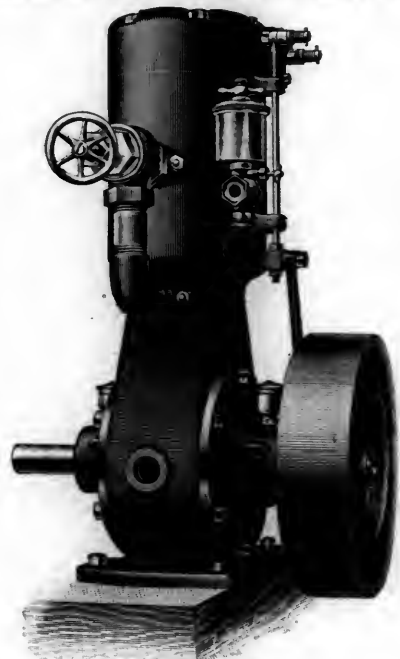
THE PROSPECTS FOR ELECTRICITY ON STEAM ROADS.

Progressive railroad officials, particularly those who are in a position to feel keenly the competition of the electric motor in suburban traffic, are fully alive to the progress and improvements in electric-power installations, and will not be slow to utilize this modern method of power transmission—for that is all that electricity is in its present uses in power plants—when it is possible to effect a saving by so doing, but we think few of them will join with the author of the paper on the "Motive Power of the Future," read before the recent meeting of the American Society of Railroad Superintendents, when that writer says: "We have arrived at a very interesting point in the evolution of railway motive power, a point of transition from old methods to new ones, a point from which it seems possible to almost certainly predict the entire change from steam to a more economical motive agent. . . . Unless, then, we make the assumption that we have reached the end of progressive development, we must admit the very great probability of the entire supersession of steam by electricity as a motive power on our railways, not only in suburban and interurban traffic, but in cross-country traffic also. Primarily, such change will take place because the perfection of economy has probably already been reached with regard to the application of steam." Nor do we think that those who are most directly concerned in the economical operation of the locomotive will agree with the opinion that the limit of possible economy has been reached in present practice. For some years past the economies sought in locomotive design have chiefly been those obtainable by a reduction of the total train expenses, rather than in the economy of the locomotive itself. As a result we have larger locomotives, heavier trains, engines that stay out of the shop longer—or make a greater mileage between shoppings—in fact, anything and everything in design and method of operation that will give the best net result on the capital invested and which will cut down the expenses per ton-mile. When all that can be has been achieved in this direction attention must then be given to the performance of the locomotive as a machine in itself to reduce to the lowest limits its coal consumption for a given duty; then, and not until then, will the locomotive reach its highest efficiency. The electric locomotive has made rapid strides in the last few years, but its best informed friends admit that under the present conditions it cannot compete with the steam locomotive for cross-country traffic. It is believed by many, however, that the developments in electricity in the near future will be of such a radical character that the cost of power in this form will be greatly reduced. If such a sweeping reduction in cost is effected there is hardly any question but that the steam locomotive will be left behind in the race. The economies which it is possible to effect in the operation of our much-respected friend, the steam engine, are considerable, but they are not extensive enough to be entitled to the term "sweeping." On the other hand the radical or sweeping changes in electric motive power necessary to permit it to take the place of the steam locomotive have not yet been made, nor is it clear that they are actually forthcoming. Many are deceived by the comparative youthfulness of electrical science into the belief that our knowledge of electricity is very incomplete and that remarkable developments may be expected at any time and from almost any direction. This is far from the truth. The discoveries in electricity came to a world of science capable of grasping their importance at once, and of pushing forward the work of investigation; they also came to an industrial world equipped with the knowledge and tools necessary for the construction of the new machinery, and the engineering ability to adapt this machinery to the wants of mankind. The result has been the development of electrical science and electrical industries with astonishing rapidity, until to-day they compare with many older sciences and industries in completeness. For these reasons it does not appear that there is, after all, so much to be expected from the further developments in electrical engineering. Since the above was written, Dr. Chas. E. Emery has presented

an excellent paper before the American Society of Electrical Engineers, in which he compares the present cost of operating a heavy trunk line with the expense of the same service by electricity. He shows that the fuel bill is only ten per cent. of the total expense of operation so that a performance at the central station of one horse-power for only two pounds of coal will result in a saving in operation of only 6.56 per cent. of the total expense after deducting the losses of transmission, etc. He concludes that there would be no saving in labor, none in repairs, and none in track maintenance. Furthermore, he shows that the great cost of the electric equipment will increase the fixed charges to such an extent that with money at 5 per cent. interest, the traffic income must be increased 12½ per cent. to pay these charges. He argues that the use of electricity in suburban travel increases the business of the road for reasons which are already familiar to our readers, but he also points out that in long-distance traffic an increase of traffic due to the electric power cannot be expected. Others supported these views in the discussion and we may safely conclude that the electricians who best understand the traffic of steam roads are the least hopeful of the immediate use of electricity in that service. We shall again refer to Mr. Emery's paper and the discussion on it next month.

A New Naphtha Engine.

This engine, shown in the perspective in the accompanying engraving, presents some entirely new features in a boat engine, which render it especially desirable as a motive power for small boats and launches. It is built by Chas. P. Willard & Company, of



A New Naphtha Engine.

Chicago, which company owns the patents covering the special features.

Heretofore, we believe, all naphtha launches have required the presence of a flame burning in the generator while it was in operation, to vaporize the naphtha, and also required the presence of several gallons of naphtha in the boat at all times. By the entirely different system upon which this engine operates, there is no fire in the boat whatever.

The engine is of the ordinary trunk piston type and the valve mechanism is of the simplest kind, consisting of a single eccentric working a lever operating two cams. There are no gears whatever.

When the engine is first started naphtha is vaporized to obtain an explosive mixture for the cylinder, but after a few minutes the engine is supplied with gas from a patented generator, which is not shown in the illustration. From this generator the gas enters the base of the engine at a point opposite the hole seen in the engraving. Through this hole air is admitted to the base, and the mixture, being slightly compressed by the downward stroke of the piston, passes through a throttle valve into the cylinder, where, after further compression, it is ignited by an electric spark.

One of the valuable features of the engine is its ability to use the lowest and cheapest grades of naphtha and gasoline on the market. There is also no flame in the boat outside of the engine cylinder. The engine can be operated at all speeds and in either direction. The amount of naphtha which is needed on the boat at any one time is much less than where it is used both as fuel and as a working vapor, and, as already stated, the oil can be of a low grade, say a 57-degree naphtha.

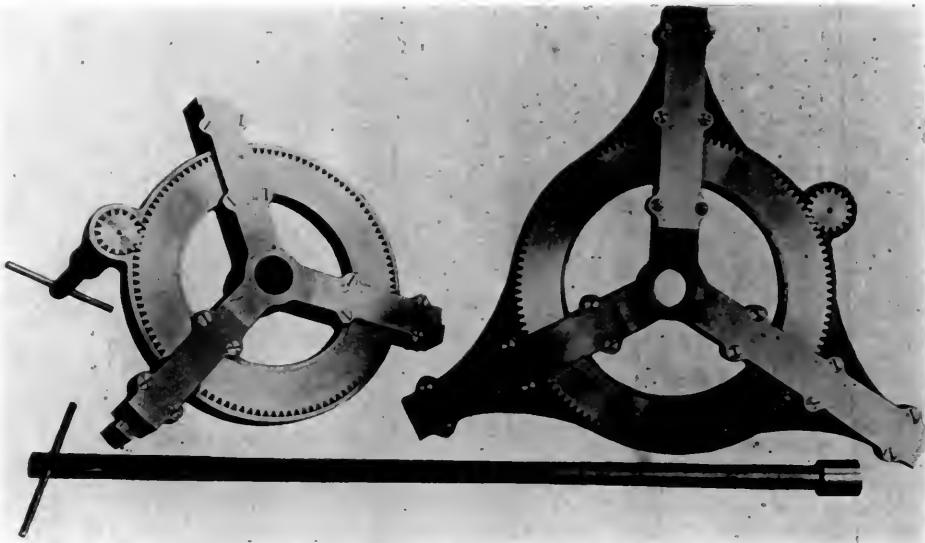
The builders, Chas. P. Willard & Company, are located at 197 South Canal street, Chicago, and will be pleased to furnish additional information. The engines are sold complete, ready to put into a boat,

means of a socket wrench on its spindle, the jaws are set out against the cylinder walls. A two-inch hole through the center of the spider is for the insertion of a turned bar or arbor which is thus held exactly central in the cylinder, and by which the guides are lined up.

It will be seen that the mechanism does away with the labor of adjusting a line or arbor to a central position in the cylinder. All that is necessary is to place the spiders in position, set out the jaws simultaneously and then insert the arbor. The latter is then located centrally and with greater accuracy than is ordinarily obtained.

The larger of the two devices shown is 28 inches in diameter and will fit cylinders from 28 to 31 inches in diameter. The smaller one is suitable for cylinders from 19 to 22 inches in diameter. As each pattern can be given a range of at least three inches, two sizes would suffice for the average railroad shop.

The device has been praised so highly by those who have seen it that the company will add it to its line of manufactured prod-



A Device for Centering Cylinders.—Made by Pedrick & Ayer Co., Philadelphia.

or boats complete and ready for operation will be furnished by the manufacturers.

A Device for Centering Cylinders.

Those who have much to do with the erecting of locomotives or with repairing them will appreciate the neat device for lining up cylinders and guides which we show herewith. It is the idea of Mr. Pedrick, of the Pedrick & Ayer Company, of Philadelphia, and was made by him in response to a request for something of the kind for use in the erecting shop of the new locomotive works in Russia. It consists of a cast-iron spider or frame provided with three steel "jaws" operated in unison similar to the jaws of a universal chuck. Two pairs of spiders were made for the Russian locomotive works, one set for the high-pressure and the other for the low-pressure cylinders of compound locomotives. They are both shown in our engraving.

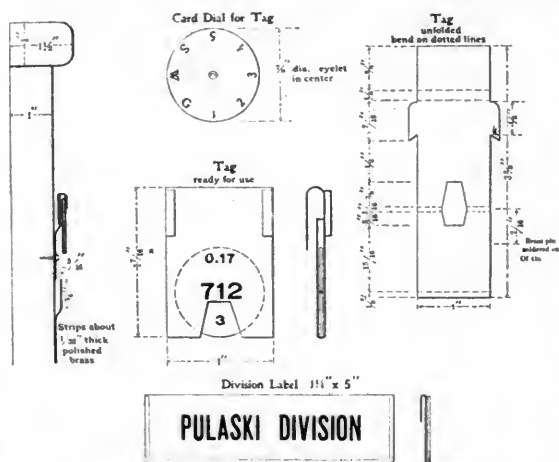
The steel jaws are neatly fitted into radial channels planed in the spider and are $1\frac{1}{2}$ inches in section. Their ends are enlarged to give a bearing face 2 by $1\frac{1}{2}$ inches by an L-shaped extension of the jaws. On the face of these jaws rack teeth are cut to engage a spiral cut on the back of the large ring gear seen in the engraving. The jaws are held in place by plates which cover them and extend across the gear also. A small pinion held in the spider frame meshes into the large gear and, by

means of a socket wrench on its spindle, the jaws are set out against the cylinder walls. A two-inch hole through the center of the spider is for the insertion of a turned bar or arbor which is thus held exactly central in the cylinder, and by which the guides are lined up.

Norfolk & Western Engine Board.

In the latest number of the proceedings of the Southern and Southwestern Railway Club we find an article describing the engine boards of the Norfolk & Western road, by R. P. C. Sanderson. These boards are believed to fulfill all requirements and are easily and cheaply made. Referring to the engraving it will be noticed that the engine board itself consists of a plain pine or poplar board (shown in section), on to the face of which are secured by screws a succession of horizontal thin metal strips (brass, Russia iron, or something similar). The shape of these metal strips is shown by the drawing, and when in place they form a succession of horizontal grooves. The headings, names of divisions and shops are indicated by cardboard labels, slipped into the label holders, which are simply hung on the metal strips at convenient positions, and can be changed ad libitum to suit changing conditions, by shifting them about, taking them off, or changing the cards in the label holders. The label holders for the names of divisions are $1\frac{1}{2}$ by 6 inches and a sample one is shown. The shop tags are $3\frac{1}{2}$ inches by 5 inches.

The engines are represented by tags of a peculiar form, as shown by the drawing. The tag is made of a sheet of tin, of the



Details of Norfolk & Western Engine Board.

shape shown, which has a small piece of brass wire soldered to it to form a center for the cardboard dial. The dial is also shown separately, and the printing on it can be varied to suit the different requirements. In the case of the dials shown the marking has the following meaning:

1. Repairs required—No. 1—which means general rebuilding.
2. Repairs required—No. 2—which means new firebox and general overhauling.
3. Repairs required—No. 3—which means general overhauling, with heavy renewals of worn-out parts.
4. Repairs required—No. 4—which means light general overhauling.
5. Repairs required—No. 5—which means light repairs, such as can be done in four or five days without removing wheels.
- S. Repairs required—Special—which means such as broken frame, broken wheel, 50 flues, etc.
- W. Repairs required—Wrecked—only used in case of heavy wreck damage.
- G. Means in good or fair order, in condition to render efficient service, and requiring nothing but current maintenance and running repairs.

After the tin is cut, the center pin soldered on, the dial is dropped on to the center pin, and the tag folded over to the shape as shown on the drawing of the completed tag. The notch or gap in the tag allows one of the figures or letters mentioned above as indicating the condition of the engine to show, as the condition changes, the dial can be quickly rotated so as to show the letter or figure representing the changed condition. Above the notch or gap in the tag is painted the engine number and the class letter or mark. Above the number and class letter is a little pocket formed when folding the tin which is used to hold small labels, either to represent the class of service of an engine in service, such as passenger (through or local); freight (through or local); pushing or helping, shifting, maintenance of way, extra or reserve, etc. In case of engine out of service in the shops, a small card label, as shown, is slipped into this pocket to show what division the engine was in service on before she was shopped.

The board in the office of the superintendent of motive power is 3 feet 7 inches deep and 6 feet wide, and gives the location, service and condition of all engines on the road. In the offices of the various master mechanics are smaller boards of similar design, giving records for their divisions only.

Notes.

The East River Bridge Commission last month received the formal approval of the bridge plans from the Secretary of War. They also entered into a contract with F. W. Miller for the borings necessary for the New York anchorages, the price being 40 cents per lineal foot.

A motor vehicle race took place last week between Paris and Marseilles and return. The distance is 1,051 miles and the first

vehicle to arrive was the Michelin motor cycle, which made the trip in 72 hours, including all stops, or at the average rate of 14.6 miles per hour.

The Pennsylvania Railroad considers the outlook so good for business after election that it has ordered all idle freight cars to be put in readiness for use on short notice. In August the number of cars passing through the Harrisburg yards is given as 62,666; in September, 73,303, and October figures show a still greater increase.

The first of the three torpedo boats which the Columbian Iron Works, of Baltimore, is building for the United States government, was launched on October 1. This boat is 160 feet long on the water line, 16 feet beam, and 138 tons displacement. The engines are triple expansion and drive twin screws. Their horsepower is to be 2,000. The contract calls for a speed of 24½ knots.

One of the twin-screw steel ferryboats for use on the Pennsylvania Railroad's new Twenty-third street ferry across the Hudson was launched at Cramp's shipyard on Oct. 17. The boat is to be called the *Pittsburgh*, and a sister ship, being built by Charles Hillman & Co., Philadelphia, is to be called *St. Louis*. The boats have been described in these columns. The chief novelty about them is the use of twin screws at each end of the boat, or four screws in all.

The Pacific Coast may soon have a new and regular source of fuel supply. An American bark recently arrived at San Francisco with a sample cargo of coal from the Tonquin District of China. The coal beds are said to be extensive, and it is also claimed that with the cheap Chinese labor available and the present tariff rates, the coal can successfully compete with the other fuels in the market on the Pacific Coast, providing the quality of the coal is satisfactory.

In a paper before the British Association Mr. E. W. Anderson relates his experience for eight years with an electric traveling crane and a steam traveling crane working side by side in a foundry. The electric crane has one motor, geared to furnish power for all three motions required, and is of 20 tons capacity. When first installed there was a prejudice against it, but now it is the favorite with the men. The repairs to the electric crane have cost less than in the case of the steam crane and in many ways the former has proved more convenient.

The great engineering work of removing the obstruction in the Danube River, known as the Iron Gates, between Alt-Orsova in Hungary and Gladova, in Servia, has been accomplished and the river opened to navigation Sept. 27. The passage of the Iron Gates has always been dangerous and much of the time wholly impracticable to vessels drawing 5 feet of water, because of the rocks and the rapids they created. Enormous quantities of rock have been removed and the river thus made navigable for the largest river steamers from Vienna to the Black Sea. It is said that the work cost nearly \$10,000,000.

The Steam Engineering Class of the Young Men's Institute, 222-224 Bowery, New York City, opened its 1896-97 session on the evening of Oct. 7, 1896, and will continue open Wednesday and Friday evenings until April 29, 1897. The class is in charge of Mr. Wm. H. Weightman as usual. Its object is the instruction of all employed or expecting to be employed in the practical operations of engines, boilers and machinery, and desirous of gaining a knowledge of or improving themselves in the theoretical branches, rules and practice of steam engine, boiler and power transmission calculations. Those desiring to avail themselves of the opportunity should join the class at once.

In the *Engineer* for Oct. 9, Mr. Chas. Rous-Marten gives some facts about the longest regular run without stops in the world. This run is made daily on the Great Western Railroad of England, between Paddington and Exeter, and is 194 miles long. The average speed according to schedule is 51.7 miles per hour. The train usually consists of six cars carried on trucks, and weighing 140 long tons behind the engine. The engine hauling the train is a 19 by 24 with one pair of drivers 7 feet 8 inches in diameter, and

a four-wheeled leading truck. The steam pressure is 160 pounds, and the heating surface 1,561 square feet. The grades are easy and the road favorable to fast running, but at Bristol the train passes around a loop to avoid the station and the curves in the track at this point compel the speed to be kept down to about 10 miles per hour. There is also one grade of 1 in 81.

The lens for the great telescope of the new observatory at Lake Geneva, Wis., has been completed after two and a half years' labor, and now lies at the workshop of Prof. Alvin Clark, in Cambridge, awaiting the orders of the Chicago University authorities. Its focal distance is 61 feet; the extreme diameter of the clear aperture is 41½ inches. The crown is about 3 inches thick at the middle, and 1½ inches thick at the outer edges, and weighs 205 pounds. The flint weighs 310 pounds. The lens and its iron ring and cell weigh about 1,000 pounds. The cost of the glass plates, in Paris, was \$40,000, and the entire cost of the lens is estimated to have been \$100,000. For its journey West it will be wrapped in flannel and bedded in curled hair in a box mounted on springs and packed with excelsior in a larger box. It will ride in the center of a parlor car, and will be accompanied by four men.

Last November one of four vertical triple-expansion Corliss engines, built by Fraser & Chalmers, Limited, of Chicago, for the De Beers Consolidated mines, Kimberly, was tested to see if it met the guarantee of the builders that the dry steam consumed per brake horse-power should not exceed 145 pounds. The engines were each of 225 horse-power. The cylinders are 11½ inches, 19 inches and 30 inches in diameter by 36 inches stroke. The engine has two cranks 90 degrees apart. The cylinders are jacketed. The steam pressure during the test averaged 123.7 pounds above the atmosphere, the vacuum 11.5 pounds. The engine made 74.6 revolutions per minute, and developed 233.86 brake horse-power and 234.32 indicated horse-power. The frictional horse-power was thus only 4.4 per cent. The dry steam per brake horse-power was only 13.5 pounds, and per indicated horse-power, 12.9 pounds, a truly notable result. The test lasted five hours.

A notable steam yacht has been designed by Mr. Charles D. Mosher, and is now under construction at Upper Nyack for Mr. Charles R. Flint, of New York City. The boat is to have a guaranteed speed of 33 knots, or about 88 miles per hour. It will be 122 feet long, 12½ feet beam and 4 feet draft. It will be driven by twin screws and quadruple-expansion engines of 2,000 horse-power. There will be independent air, feed and circulating pumps, electric-lighting plant, and blowers for forced draft. Steam will be supplied by two Mosher water-tube boilers. The hull of the boat will be divided into seven compartments by water-tight bulkheads. The coal bunkers will be of large capacity. The fittings of the boat will be excellent, but the most interesting feature is the facility with which all the upper works can be removed and replaced with a turtle-back deck and two conning towers. Simultaneously with this change the boat can be fitted with torpedoes and rapid-firing guns, thus converting the yacht into one of the fastest and most effective of torpedo boats.

The last session of the Mexican Congress amended the existing patent law of that country, so that article 33 reads as follows: "The owner of a patent is obliged to prove to the Department of Encouragement at the end of each period of five years of the life of the patent that, with a view of maintaining it for another five years, he has paid into the general Treasury of the Federation the sum of \$50 at the close of the first five years, or \$75 at the expiration of ten years, and \$100 at the expiration of fifteen years. All these payments have to be made in Mexican dollars. The term within which these payments have to be proved shall be two months after the conclusion of each period of five years. This term cannot be extended. Persons who up to the promulgation of this law shall have lost their patents under Section 3, Article 37 of the law of June 7, 1890, may avail themselves of the benefits of this law to save their patents, provided they pay the proper fees within three months of such promulgation. But

the patent thus revived is without prejudice to the rights acquired by other parties subsequently to the declaration of forfeiture."

The Joint Select Committee, created at the last session of Congress, to investigate and report upon the question of the use of alcohol free of tax in the manufactures and arts, have prepared a series of interrogatories, which will be distributed throughout the country to such parties as are thought to be interested in the question. It is the earnest desire of the committee to secure all possible information bearing upon the subject, and it is hoped that parties interested will submit their views to the committee promptly. Sets of the circular letter and blank for replies will be supplied to any applicant by addressing the Chairman, Room 21, Senate Annex, Washington, D. C. The committee, which is composed of three members of each House, will probably assemble in Washington soon after the middle of November for the purpose of formulating a report to Congress accompanied by the draft of a law which will place domestic industries on as favorable a basis as similar industries in foreign countries. During their sessions in Washington hearings will probably be given in order to supplement the information obtained through the interrogatories sent out by mail.

The New York *Tribune* says that the United States Naval authorities have tested and found highly satisfactory an improved Howell torpedo. The new torpedo is larger than any of that type previously tried, some of its dimensions being as follows: Extreme length, 14 feet 6 inches; greatest diameter, 17 inches; net weight of gun cotton in charge, 174 pounds; net weight of water-wetting charge, 43.6 pounds; net weight of dry gun cotton in primer, 2.35 pounds; immersed displacement in sea water, 1,150 pounds; launching weight of torpedo, 1,130 pounds; reserve buoyancy, 20 pounds; mean speed over range of 400 yards, 33 knots; over 600 yards, 30 knots; over 800 yards, 28.5 knots. The extreme effective range, as adjusted for regular service, is 1,000 yards; the deflection from beam fire at a ship with a speed of 17 knots, 5 degrees; weight of fly-wheel, 30 pounds; most efficient fly-wheel speed at start, 9,600 revolutions per minute; pitch of screw at start, 14 inches; pitch of screw at finish, 29 inches; diameter of screws, 10 inches. The total displacement weight of a center pivot launching tube is 2,303 pounds; that of the tube proper, 1,153 pounds; of a carriage, 422 pounds; of a racer, 98 pounds; of the motor, 330 pounds; of the piping to swivel, 200 pounds. The weight of a powder blast in the cart-ridge case is six ounces.

The North Atlantic squadron passed through the heavy gale of last month when on its way from Hampton Roads to New York. Most of the ships behaved well in the storm, but the crew of the battle-ship *Indiana* had an experience they will not soon forget. Captain Evans gave an account of it, from which we take the following: "Soon after we left Hampton Roads Monday all four of the 8-inch turrets broke loose at once from their gearing. That was about 2 o'clock in the afternoon. We went to work with 5-inch hawsers to tie the guns up. We tied the two forward turrets together by binding the guns each to the other and fastening the hawsers to the bits, and managed the aft ones the same way. It was a very hard job. About 2 o'clock the next morning the forward ones snapped their hawsers and got loose again. The storm was then very severe, and the ship was rolling at an angle of 36 degrees. The decks were flooded with water, and this, with the pitching of the ship, made working on deck very dangerous. To make matters worse, the forward 13-inch gun turret got loose, and those enormous guns began thrashing about in full command of the deck. We fastened a 5-inch hawser on the 13-inch gun and it snapped like a cotton string. We finally caught the big guns with an 8-inch hawser and tied them securely to the superstructure. It was an awful job, though, and we were in danger of being washed overboard every minute. All during the work the deck was completely flooded."

A series of interesting tests were recently made on short sections of wire cable in the laboratory of the Yorkshire College, Leeds, England, and described in *Engineering*. In making the

tests it was found that none of the cappings supplied by the makers was at all satisfactory; most of them gave way at about one-half the breaking load of the rope, when taking the strength of the rope as the sum of the strength of the wires tested individually. After several experiments it was found that the only really satisfactory method of making the strength of the cap approximately equal to the strength of the rope is as follows: Before cutting off a sample length from the bulk of the rope, it is tightly bound with wire at about six inches from the end, and then cut off. The specimen is then tightly served with tarred band from end to end, in order to keep the strands in their proper position. The ends are then frayed out, and the end of each wire turned over; each end of the rope is then put in boiling caustic soda to remove tar and grease, thoroughly washed in hot water, then dipped in "killed spirits"—i. e., chloride of zinc, and afterward in molten solder; each wire then gets tinned. The ends are then put into split conical dies, and an alloy, consisting of lead, tin and antimony, is cast round it, which completes the capping process. The rope is then pulled apart in the testing machine, the ends being held in conical dies. The results of seven tests show that the breaking strains of from 12,960 pounds to 55,500 pounds for the different ropes were all from 93.4 to 96.2 per cent. of the sum of the strengths of its component wires.

Consul Merritt, of Barmen, describes Herr Linde's process for the manufacture of liquid air, whereby also oxygen gas is obtained at a cheaper cost than that produced by the methods now in use. A powerful engine compresses air, which is cooled, as far as possible, by ordinary refrigerating methods and passed into a spirally coiled pipe a hundred yards long. This pipe is enclosed in a second spiral. By means of a throttle valve at the end of the inner spiral, a certain proportion of the compressed air is allowed to expand in the space between it and the outer pipe. Thus the stream of compressed air from the pump is cooled by that portion which has been allowed to expand, and arrives at the throttle valve in a colder state than the portion that preceded it. Consequently, it reaches a still lower temperature on expansion, cooling yet more powerfully the advancing stream in the inner tube. By carrying this cumulative cooling effect sufficiently far, the circulating air is at least brought down to its critical point and liquefies, after which a continuous stream of liquid air is merely a question of engine power. The cycle of operations can be readily apprehended; there is compression, expansion in a closed chamber, and utilization of the cold thus produced to repeat the cycle from a lower initial temperature. The apparatus produces with the greatest ease a substance for which there is already a large industrial demand—oxygen gas. During the process just described, the air becomes steadily richer in oxygen until that gas forms some 70 per cent. of the product. This relatively pure oxygen is sufficiently good for certain purposes, and it may be further purified from nitrogen if desired.

The trouble encountered again during the past season with the Belleville water-tube boilers in the Northern line passenger steamers *North Land* and *North West*, especially the latter boat, has been the subject of a great deal of comment among engineers on the lakes, and rumors have been circulated about new boilers being adopted. Builders of the steamers have disclaimed any responsibility for difficulty with the boilers, as they hold that they opposed the adoption of them at the outset. Mr. Miers Coryell, who represented the French owners of patent rights on the boilers, and who, even up to the close of the passenger season this year, has been trying to straighten out the trouble, claims that the unsatisfactory operation of the ships has been due entirely to negligence in the management of the fire rooms. He writes from New York at considerable length on the subject, and in part says: "Among some of the practices which prevailed, and which the engineers estimated they could not prevent, were the following: Heavy fires, brought on by charging the furnaces with lumps of coal that were limited in size only by the dimensions of the furnace doors; ash pans full of dirt and clinker; furnace doors wide open half the time; damper doors kept wide open; boilers too full

at times and again allowed to run scant of water, thereby damaging them; fireroom force cleaning a number of furnaces at a time, and in fact, conducting work of this kind at their leisure, allowing the steam pressure to drop as much as 100 pounds; then further delay by fires too thick to allow a passage of air through them, and a consequent discharge of clouds of black smoke instead of kindling fires in the furnaces. Then, too, the discharge pumps for disposal of ashes were run without a mixture of water with the cinder, which was equivalent to rotating them in emery. It would seem that they were purposely rendered useless, in a spirit of destruction and wickedness. As a result of this the boats would reach port with firerooms 18 inches deep with ashes."—*Marine Review*.

Personals.

Mr. E. L. Langford has been chosen President of the Brooklyn & Brighton Beach, to succeed James Jourdan.

Mr. G. H. Clark, Jr., has been elected Vice-President of the Northampton & Hertford Railroad, with office at Newark, N. J.

G. M. Stewart, previously Acting General Manager of the Inter-oceanic Railway of Mexico, has been appointed General Manager.

Mr. Henry Kistner has been appointed General Foreman of Motive Power and Car Departments of the Monterey & Mexican Gulf.

Mr. H. L. Hawkins has been appointed Chief Engineer of the Oregon Improvement Company, with headquarters at Seattle, Wash.

Frederick A. Lex, formerly with A. Whitney & Sons, has become identified with the Lobdell Car Wheel Company of Wilmington, Del.

Mr. F. G. Patterson, President and Superintendent of the Altoona, Clearfield & Northern; was last month appointed as Receiver of the road.

Mr. J. A. Atwood, heretofore Principal Assistant Engineer of the Pittsburgh & Lake Erie, has been appointed Chief Engineer in place of Mr. F. E. House.

Mr. W. W. Wentz, Jr., has been appointed Secretary and Purchasing Agent of the Louisville, Evansville & St. Louis, with headquarters at Louisville, Ky.

Mr. Horace G. Burt has resigned as General Manager of the Chicago, St. Paul, Minneapolis & Omaha, to become Third Vice-President of the Chicago & Northwestern.

Mr. Edwin Hawley, of New York, Vice-President of the Minneapolis & St. Louis, was on Oct. 6 chosen Vice-President of that road to succeed Mr. W. L. Bull, resigned.

Mr. H. Walter Webb, Third Vice-President of the New York Central, New York City, has been appointed Temporary Receiver of the Ogdensburg & Lake Champlain Railroad.

Mr. Frank J. Sarnan, Master Mechanic on the Manitou Beach Railroad, has been appointed Superintendent, succeeding Mr. George C. Mills. Mr. Charles Sarnan succeeds him to the position of Master Mechanic.

M. J. F. Sechler has resigned as Master Mechanic of the Louisville, Evansville & St. Louis at Princeton, Ind. Mr. F. C. Cleaver, formerly Master Mechanic of the Vandalia line at Terre Haute, Ind., has been appointed in his stead.

Mr. Charles E. Levy, President of the New Orleans & Western Railway, has resigned, owing to poor health. Mr. W. Mason Smith, the Vice-President, was chosen to fill the vacant position, and Mr. W. W. Pierce was elected Vice-President.

Mr. Henry Fink, one of the Receivers of the Norfolk & Western, has been chosen President of the reorganized company which took possession of the property October 1. Mr. F. J. Kimball,

heretofore President and Receiver, is Chairman of the Board of Directors.

Mr. W. H. Brehm has been appointed Master Mechanic of the Missouri, Kansas & Texas north of Denison, Tex., with headquarters at Parsons, Kan. Mr. John L. Wigton has been appointed Master Car Builder of the lines north of Denison, Tex., with headquarters at Sedalia, Mo.

Mr. W. H. Stark has resigned his position as Master Car Builder of the Wheeling & Lake Erie Railway Company to give his attention to railway supply matters. Mr. Stark has an interest in several valuable railway appliances patented by him, which will probably be on the market in the near future.

Gen. Horace Porter, who has been first Vice-President of Pullman's Palace Car Company for many years, has resigned that office owing to his election to the position of Chairman of the Board of the St. Louis & San Francisco. The former second Vice-President, Mr. T. H. Wickes, succeeds General Porter as first Vice-President.

Mr. J. M. Wallace, Superintendent of Motive Power of the Pennsylvania Railroad at Altoona, Pa., will succeed the late Mr. Neilson as General Superintendent of the Philadelphia & Erie and the Northern Central Railroad. Mr. Wallace will be succeeded as Superintendent of Motive Power by Mr. W. W. Atterbury, now at Fort Wayne.

Mr. E. W. Knapp, Master Mechanic of the Mexican National, at Acambaro, Mex., has been transferred to the City of Mexico, and Mr. R. Fitzsimmons, Acting Master Mechanic at the latter point, has been appointed Foreman of Engines at Saltillo. Mr. E. D. Stegall has been appointed Master Mechanic of the Mexican National at Acambaro, Mex.

The promotion of Mr. F. W. Brazier from the position of General Foreman of Car Works to that of Assistant Superintendent of Machinery of the Illinois Central Railroad will please his many friends. Mr. Brazier came from the Fitchburg road to take charge of the plant of the Chicago, New York & Boston Refrigerator Company at Elsdon, Ill. Later he accepted his recent position on the Illinois Central.

Mr. Walter A. Scott, General Superintendent of the Chicago, St. Paul, Minneapolis & Omaha, has been appointed General Manager of that road, with headquarters at St. Paul, Minn., to succeed Mr. H. G. Burt, and the office of General Superintendent has been abolished. Mr. Scott was formerly Master Mechanic for ten years and Assistant Superintendent of Motive Power and Machinery for two years on the Chicago & Northwestern.

Last month we were in error in stating that Mr. R. P. C. Sanderson had resigned the position of Division Superintendent of Motive Power on the Norfolk & Western Railroad. The office of the General Superintendent with the staff belonging to that department was abolished on the Norfolk & Western Railroad, and Mr. Sanderson's position as a staff officer of the general superintendency was abolished with the general superintendency, but the duties of that position are being performed by him much the same as before, but under the Superintendent of Motive Power's supervision instead of under the General Superintendent's.

Mr. Robert Neilson, General Superintendent of the Philadelphia & Erie and Northern Central roads of the Pennsylvania system, died very suddenly at his home in Williamsport, Oct. 12. Mr. Neilson was born in Ontario, Canada, Aug. 19, 1837. He graduated from Rensselaer Polytechnic Institute in 1863, and immediately entered the service of the Pennsylvania Railroad as rodman on the Philadelphia & Erie. In 1865 he became Resident Engineer of the middle division of that road. In 1870 he was promoted to the Superintendency of the Western Pennsylvania division, and in 1874 he was appointed to a similar position on the Elmira and Canandaigua division of the Northern Central. In 1881 he was made General Superintendent of the Philadelphia & Erie and of the Northern Central north of Harrisburg, and in 1884 his responsibilities were extended to embrace the entire Northern Central. The duties of this position he discharged with great ability until his death. He had been in the service of the Pennsylvania for over 30 years.

Equipment Notes.

The Green Bay & Western is asking bids on 150 box cars.

The Cudahy Packing Company is in the market for 50 refrigerator cars.

The Winona & Western Railroad has ordered two locomotives from the Dickson Locomotive Works.

The Lima Locomotive Works have an order for one Shay locomotive for the Morning Mining Company.

The Louisville & Nashville has given out a contract for 15 engines, and it is asking bids on 300 gondola cars.

The Keokuk & Western road has contracted with the Rogers Locomotive Works for three 10-wheel locomotives.

The Spokane Falls & Northern Railway has contracted for one six-wheel connected engine with the Baldwin Locomotive Works.

The Michigan-Peninsular Car Company, Detroit, have been given an order for building 1,000 freight cars for the Erie Railroad.

The Georgia railroad, it is reported, has placed an order for 100 freight cars with the Youngstown Car Manufacturing company.

The Portland Company, Portland, Me., has an order for five four-wheel connected engines from the Grand Trunk Railway of Canada.

The St. Charles Car Works have delivered to President E. H. R. Green, of the Texas Midland Railroad, the private car recently completed for him.

Wells & French have been given the contract for building 100 refrigerator cars for Swift & Co. The latter company are asking bids on 50 stock cars.

The Stone, Coal and Lumber Freight Line of Atlanta, Ga., has recently contracted with the Car Trust Investment Company of New York for 200 cars.

The Rock Island Railroad is building at its own shops two fast locomotives of the designs recently gotten up by Mr. Wilson, and which have proved so satisfactory.

The International Great Northern has built a number of drawing-room cars for service between St. Louis and Galveston. They have 12 sections, and are supplied with buffets.

It is again reported that the Butler & Pittsburgh will soon be in the market for much of its new equipment, but the report is denied, and it is said that no orders will be placed before spring.

Rotary Acceleration.

A correspondent of the *Practical Engineer*, in commenting on an editorial in that paper on "train resistance," has the following to say about rotary acceleration:

"You remark that there is the rotary acceleration of the wheels and axles, which has, we believe, been nearly always neglected, but which forms, nevertheless, a very important part of the whole resistance, prompts me to say that there is an equal and universal tendency to ignore the effect of rotary acceleration in our text-books on mechanics. How often do we not find the little carriage running down an inclined plane with an acceleration calculated with total disregard of the rotary acceleration of the wheels? and without any hint that any such a connection to the calculation is needed. One occasionally even finds in standard text-books a problem given, in which a body is expected to roll down an inclined plane in exactly the same time as it would slide down if there were no friction. I take the following exercise from a well-known elementary text-book: 'Show that the velocity acquired by a body rolling down a smooth inclined plane is the same as that acquired by falling vertically through the height of the plane.' It appears to me that such an exercise, found with others in good text-books, is in itself a proof that the difference between sliding and rolling is not sufficiently brought to the front by teachers of mechanics. It is assumed in these cases that a body rolling down an inclined plane or along a smooth surface, under the influence of any force, will be subject to the same acceleration as when sliding down the plane or along the surface under the same force, which, of course, is not true.

A very simple experiment serves to bring out forcibly the great

influence of rotary acceleration upon the velocity acquired by wheels of different types. If a table napkin ring (a turned one) and a common cotton reel of nearly equal weight and diameter be procured, and set to roll down a drawing board tilted to a good inclination, it will be found that the reel will reach the bottom much sooner than the ring, owing to the mass of the ring being concentrated so near its periphery compared with the reel, that a much larger proportion of the energy due to the fall has to be spent in giving the ring its rotary acceleration. Indeed, in the case of a ring indefinitely thin, just one-half the energy is required for rotary acceleration, and the other half for the movement of translation. And hence, if a wheel could be made with all its mass concentrated in the center, such a wheel would reach the bottom of an inclined plane by the time the indefinitely thin ring had got half way only.

European Boiler Practices.

Mr. R. S. Hale, M. E., has recently submitted a report to the Steam Users' Association, of 31 Milk street, Boston, Mass., giving the results of his investigation upon European boiler practices, Mr. Hale having visited England, Germany, France and Belgium for this purpose. From a summary of it by the *Engineering Record* we take the following:

Regarding the types of boiler in use in the year 1895, Mr. Hale found that in England 38 per cent. were Lancashire and similar types, 23.7 per cent. Cornish, 6.8 per cent. of the externally fired cylindrical type, while the boilers of the water-tube type were found to be 1.8 per cent. In France the percentage of Lancashire and Cornish boilers is exceedingly small, while the externally-fired cylindrical leads the list at 57.3 per cent. The externally-fired multi-tubular, which evidently corresponds with the American return horizontal tubular boiler, represents 13.4 per cent. of the boilers in France, while none was found in England. The percentage of water-tube boilers in France was 5.7. In Germany the Lancashire represents 35 per cent., the Cornish 15 per cent., the externally-fired cylindrical 14.8 per cent., externally-fired multi-tubular 5.8 per cent., the locomotive 17.3 per cent., water tube 4.6 per cent.

The Lancashire boiler which, as we previously mentioned, is found in England, is generally 30 feet long by 7 feet 6 inches in diameter. It has two internal flues about 3 feet in diameter and a grate in each of them generally 6 feet long. Galloway or cross-tubes, 6 inches in diameter, five to each flue, are often placed in the flues back of the bridge wall. The gases after passing through the flues pass underneath the boilers to the front and then back along the sides to an underground flue. Such a boiler would have 30 square feet of grate, and 1,000 square feet of heating surface. Mr. Hale said that when built for 160 pounds steam pressure, the boiler costs about \$2,500 in England, and that it will easily deliver 6,000 pounds of steam per hour and more, although at this rate it is not very economical; but where used at a lower rate of combustion, or in conjunction with an economizer, it is as economical as any type of boiler. The boiler is easily cleaned and the outside is of easy access. The Cornish boiler is exactly like the Lancashire except that it has but one flue, placed in the center in England, while in Germany it is frequently placed to one side, with the idea of improving the circulation. The Galloway boiler is generally classed as a Lancashire, which it resembles in every respect except that the two furnaces meet back of the bridge wall in a single large flue filled with Galloway tubes.

Mr. Hale finds English workmanship fully equal to our best. In England, he states, no punching is allowed and the plates are always planed on the edges and then drilled in place. Steel is being used almost exclusively in England, while iron is still preferred in some places on the Continent. English makers usually figure on 20 years as the average life of a boiler.

Mr. Hale said that the internal flues in the Lancashire boiler are generally welded along the longitudinal seam, and the cross or Galloway tubes are frequently welded in. He did not hear of any case of welding a boiler shell itself. Mr. Hale stated that corrugated flues were made in various ways, and that while they were considered better in England, it was thought that most frequently the improvement did not warrant the expense. In comparing steam pressures it was found that for an American mill operating under 150 pounds pressure, the corresponding practice would be 200 pounds in England, 180 in Alsace and 150 in Belgium and Germany.

Economizers were much more general in Europe than in American practice. One economizer was generally put in for each battery of

boilers, making the heating surface the same as the heating surface in the boiler. He noted that in some plants where economizers had been taken out the heating surface of the boilers had to do more than double to get the same economy. One advantage claimed for economizers and the Lancashire boilers was that the large amount of hot water in them offered a reserve of heat for a sudden call.

The use of superheated steam is very much in the air all over England, and in Alsace it is fairly general, about 500 superheaters being in use. There never has been any doubt that they save from 10 to 20 per cent. of coal, but the difficulty has been, Mr. Hale said, in the lubrication of the engine cylinder and in keeping the joints of the superheater tight.

Regarding grates, the practice in Germany in the case of under-fired boilers was to incline the grates downward to the rear as much as 18 inches, as it was thought to be easier for the firemen and to give better combustion.

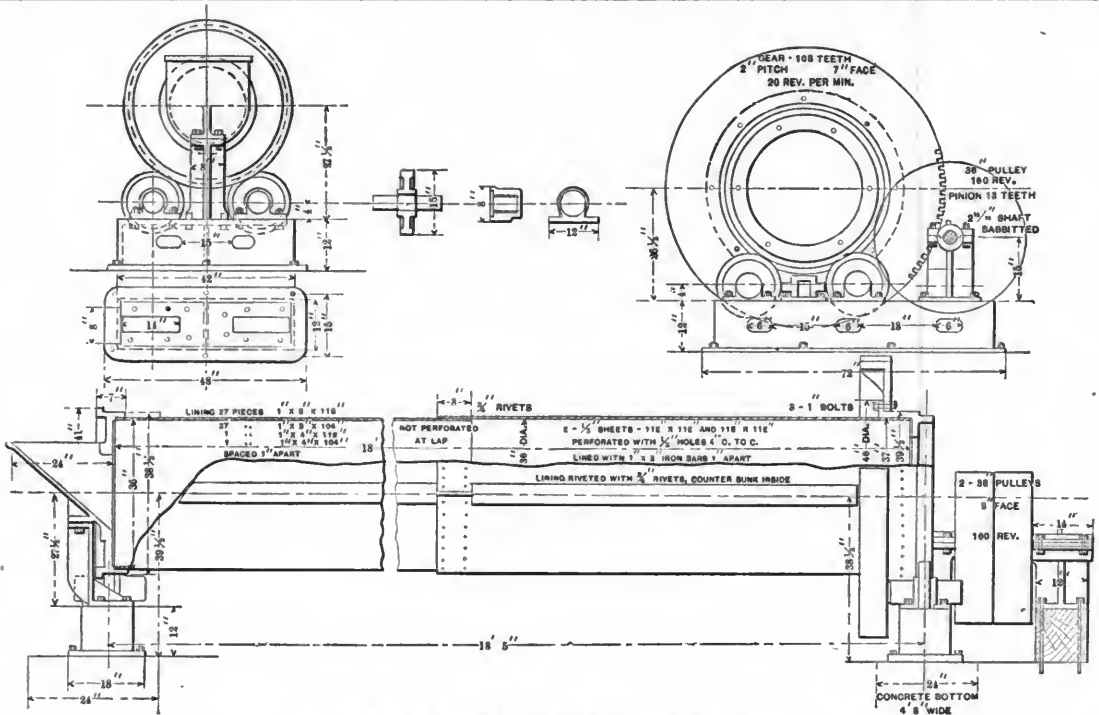
The report states that several forms of economical stokers were in use in England, perhaps over one-fourth of the boilers being equipped. Mr. Hale divides the stokers into two classes, the coking and sprinkling stokers, the former type feeding the coal to the front, where it cokes and is then carried to the rear by the reciprocating motion of the gratebars. The sprinkling stokers throw the coal over the grate by means of revolving or oscillating shovels. Mr. Hale found stokers of the former type to be the best known. It is believed in England that no stoker absolutely prevented smoke, but that both types very largely diminished it, the coking stoker having the advantage in this respect. The opinion is divided as to the economy of stokers. The most general reason for their adoption was the diminution of smoke, the laws being very strict. They also permit of the use of a cheaper fuel, but Mr. Hale is inclined to believe that the net saving in this direction after paying the interest and repairs amounted to little or nothing. The use of stokers and coal-handling appliances together was thought to save about one-third of the boiler-room labor in large plants.

In Germany grinding the coal to a powder and blowing this dust coal mixed with air into a hot combustion chamber was a method that was being experimented upon in several plants and was meeting with considerable favor. The fine dust, however, was not only very dirty to handle, but exceedingly liable to spontaneous combustion, and the problem of grinding and storing it had not as yet been commercially solved.

Boiler fittings abroad were noticeably heavier and stronger than in America and the use of a spring-loaded safety valve was looked upon with distrust. The average quality of the boiler and pipe coverings did not impress Mr. Hale as favorably as those in America. He had seen wood and even rope covering on high-pressure piping. In this respect Mr. Hale also calls attention to the wise practice of covering the top of boilers with a thick cheap covering to prevent the radiation of heat, this being generally done abroad.

In speaking of boiler operation Mr. Hale found that the surfaces of boilers were kept in a cleaner condition abroad than in this country. In some places they run the boiler until the specific gravity of the water is 1.005 and then they blow out and clean the boiler. In England they use soda, lime and potash in the boilers according to the impurities. In mills the fires are banked at night, while in electric stations the custom was very general to let the fires go out when they were not needed. Mr. Hale ascribed this difference not to the fact that a mill fire is out of use for a less time (14 hours) than an electric station fire (16 hours), but to the fact that in the case of a mill the new fire must be started at, say, 4 a. m., when it would involve an extra shift of men, whereas in electric stations the fire is needed at about 4 p. m. and involves no extra labor. From data given by several plants it was found that the cost of banking fires was about 40 pounds of coal per day per square foot of grate. The wages of the firemen are about \$1.10 per day in England, 80 cents in France and Belgium, and 87 cents in Germany.

In boiler economy he could not see that they were either ahead or behind us; they get from 60 to 80 per cent. of the heat in the coal according to the air supply and evaporation per square foot of heating surface. None of their engineers had ever found any combustible gases in the chimney except occasionally a little CO (carbonic oxide). Most of their tests, however, left some zero to 15 per cent. of the heat unaccounted for, which may be radiation or error. Some said one, some the other. No one had experimented as to why it is harder to supply the right amount of air to one kind of coal than to another, though they had all gone as far as to realize the immense importance of the air supply as compared with any



Scrap Rattler at the Schenectady Locomotive Works.

other factor in boiler economy, and also to realize and to experiment on the amount of air that leaks through the settings of some types of boilers to the injury of the economy. Frequently more air has been found to leak through the settings than came through the fire. In some plants on the Continent they were painting the brick settings with a heavy tar paint to make them air-tight, and occasionally even inclosing them in sheet-iron casings. In Germany they have an instrument called the gas-balance which shows the per cent. of CO₂ (carbonic dioxide) in the flue gases on a dial like a steam gage. If not too delicate it promises to be of great practical use.

The special instruments used for boiler testing were the ordinary thermometer for low flue temperatures, and for high temperatures the electric resistance pyrometer, in England; the thermoelectric pyrometer used in Germany, and the mercury thermometer with compressed nitrogen or carbonic acid over the mercury, reading to 550 degrees Cent. (about 1,000 degrees Fahr. English measure). For analyzing flue gases the Orsat apparatus is most commonly used.

A Scrap "Rattler."

At the Schenectady Locomotive Works a great deal of scrap is worked up into forgings for the parts of locomotives. It was found that much better forgings could be made if the scrap was clean, that is, free from rust, scale and other impurities. In order to clean the scrap they have erected a rattler, shown by the engravings herewith. This consists of a wrought-iron cylinder 36 inches in diameter and 18 feet long, which is mounted on two pairs of friction rollers clearly shown in the end views. The drum is revolved by suitable gearing at one end, driven by a belt and pulleys. The scrap is fed into the drum at one end by a sort of hopper, and has a downward inclination from that end to the other, so that as it revolves the scrap is moved slowly from the mouth, as it may be called, toward the opposite end, where it is delivered freed from its impurities.

Some of our readers will remember Mr. Outerbridge's experiments, which showed that iron was increased in strength by rattling. Whether the forgings made of rattled scrap are stronger than those made from iron not treated in this way is probably not known.

The Aylmer Branch of the Canadian Pacific Railway Operated by Electricity.

The latest development in Canadian electric railway work is the equipping of the Aylmer branch of the Canadian Pacific Railway with electric service. This line extends from Hull, a suburb of Ottawa, to Aylmer, where it connects with the Pontiac Pacific Junction Railway, extending 60 or 70 miles up the north side of the Ottawa River. The section from Hull to Aylmer has been leased by the Hull Electric Company for a period of 35 years, the understanding being that, besides passenger and mail traffic, they are to handle all through and local freight delivered to them by either the Canadian Pacific Railway or the Pontiac Pacific Junction Railway. As they are the only connecting link with the Pontiac Pacific Junction road, it can readily be understood that the quantity of freight is considerable, amounting usually to 50 or 75 cars per day. This freight is mostly handled at night, leaving the road free during the day for passenger traffic.

At the Aylmer end of the line the company owns 60 acres situated on Deschene Lake, a sheet of water 3 miles wide by 27 miles long; an ideal spot for sailing and boating, thus forming a strong attraction for the Ottawa citizens. Indeed, the traffic has been far beyond expectations, and the train service had to be increased, until they are now running 36 regular trains each way per day, besides special excursion trains.

The power is obtained from Deschene Rapids, where the lake of the same name empties itself into the Ottawa River, at a point midway between the terminus of the road. The turbine wheels are of the "New American" type, manufactured by William Kennedy & Sons, of Owen Sound, Ontario, and operated under a head of nine feet. Four 60-inch wheels are now installed and space is provided for two more.

The electrical equipment of the power-house consists of two M. P. 4-200-425 generators, built by the Canadian General Electric Company. For controlling the output of these machines there is a switchboard, consisting of two generator panels, two feeder panels and a total output panel, all of the General Electric standard type and supplied by the Canadian Company. Besides these, there are three panels containing the "Barbour" water-wheel regulator, by which the current output of the generators is automatically kept constant by cutting in or out dead resistance as the load varies on the line. By this means the speed of the machines is kept con-



Ten-Wheel Passenger Locomotive for the Erie Railroad.—Built by the Brooks Locomotive Works.

stant and the variation in voltage is held within a very close limit. The car sheds and repair shops are also at Deschene and are fully equipped with all modern appliances for handling and inspecting the rolling stock which at present consists of five closed cars and five open cars, besides a mail, baggage and express car and a locomotive. All the cars are mounted on two trucks each, and are each equipped with two G. E. 1,200 motors with K. 21 controllers. The closed cars are 42 feet long over all, and finished in mahogany throughout, the outside sheeting being also solid mahogany finish, in the natural wood.

The locomotive is of particular interest, being the first of the kind operated in Canada. It weighs something over 20 tons and is provided with double trucks, each axle being equipped with a motor. As all the wheels are driven, full traction advantage is obtained from the total weight and a draw-bar pull of 10,000 pounds can therefore be expected.—*Electrical Engineer.*

Ten-Wheeled Passenger Engine for Erie Railroad.—Built by the Brooks Locomotive Works.

The engine shown herewith is one of five ten-wheeled passenger engines built for the Erie Railroad by the Brooks Locomotive Works. They have 20 by 26-inch cylinders, driving wheels 63 inches in diameter, a boiler 64 inches in diameter, firebox 107½ by 40½ inches, 282 flues 2 inches by 13 feet 2 inches, a driving-wheel base of 13 feet 6 inches, total engine-wheel base of 24 feet 2 inches, and weigh in working order 108,000 pounds on the drivers. The total weight of the engine is 144,750 pounds, and of the tender 87,000 pounds. The boiler pressure carried is 180 pounds. The boiler is of the radial-stay type. The firebox is of carbon steel, the stays of Taylor iron. The engine truck has a swing motion and is carried on Paige steel-tired wheels. Other fittings are United States metallic packing, American balanced valves, Magnus bearing metal, Metropolitan and Monitor injectors, one each, McDowell inside boiler checks, Fox pressed steel truck frames, Kewanee brake beams, Morris steel-box lids, French springs, Magnesia boiler covering, pressed steel cylinder-head casings and boiler front and door, Gould and Thurmond couplers, Kelly headlights, Westinghouse brakes, Gollman bell ringer, Ashcroft steam gage, Consolidated muffled pop valves, Detroit lubricators, and Midvale tires. The firebox rings are double rivetted. The main and side rods are of steel, with oil cups forged on, and all the axles are of hammered steel.

Cast-Iron vs. Steel-Tired Wheels.*

Recently this question was forced on the writer's attention by some articles and notices in the technical papers, which if believed in and followed up to their natural conclusion would lead one around to the steel-tired wheel makers' door for wheels for pas-

senger cars, and necessitate the purchase and installation of wheel lathes at all the shops, increasing the first cost and maintenance cost of the passenger train considerably.

A search through the newspaper records of accidents for 1895 showed that there were just 22 cases of wrecks or derailments, freight and passenger, caused by broken wheels in this year, while there must have been something like 9,720,000 chilled iron wheels constantly in service under both passenger and freight cars during the year. The following is believed to be a fairly correct estimate of the number of accidents caused by broken wheels 1886 to 1894 inclusive:

1886.	1887.	1888.	1889.	1890.	1891.	1892.	1893.	1894.
37	27	48	28	37	39	46	48	33

While considering the question of relative safety, it is proper to mention that the steel-tired wheels are not the perfect panacea for the broken wheel problem. Reference to the M. C. B. reports on steel-tired wheels will show records of very considerable percentage of failures, and reference to the Board of Trade returns for the English railroads, and to the reports from the German Railway Union, show a considerable number of steel-tired wheel failures and some accidents from these, but the figures are not in such shape that comparisons can be made.

In a published report of some experiments made on the Pennsylvania Railroad, to ascertain the effect of heating the treads of chilled wheels,* it is stated that chilled wheels of various makes were placed in the sand and molten iron poured around the tread, when it was found that a large proportion of the wheels so tested cracked and broke, while the wheels made at the Altoona foundry would almost all stand this treatment without breaking. We can assume that wheels can be made at a reasonable cost that will stand such a test at other foundries as well as at Altoona, and can be bought at a small advance in price, if we insist on having them, and will pay for them. That a wheel in actual service will never be heated in such a manner as these test wheels were heated is reasonably certain. It is believed that leaving a red-hot brake shoe set against a standing wheel is very apt to cause cracked wheels, because severe strains would be set up in the plates and ribs due to the local heating.

Assuming that there are about 34,000 passenger equipment cars in constant service and that the numbers of wheels in service under these cars (four and six-wheel trucks) would approximate 306,000; that a first-class chilled 33-inch wheel weighs 600 pounds and that the average weight of the steel-tired 33-inch wheels (see M. C. B. report of 1895) is 802 pounds—some of them weigh over 1,000 pounds—this would mean that the difference in the weight of this many wheels alone, as between cast-iron and steel-tired wheels, would be 30,900 tons, which we would be burning coal to haul, at speeds up to and over 60 miles per hour, around the country.

Now, as regards the running qualities of steel-tired vs. chilled

*The results of these experiments were published in THE AMERICAN ENGINEER, CAR BUILDER AND RAILROAD JOURNAL for June, 1896, and have not appeared elsewhere, except as they have been copied from or have been suggested by our account.—EDITOR.

*From a paper before the Southern and Southwestern Railroad Club by R. P. C. Sanderson.

wheels, it is an indisputable fact that chilled wheels can be turned out equally true for much less cost. I have it on certain authority that it costs to grind a pair of new 33-inch wheels, mounted on the axle, for labor, 18 cents; emery wheel worn off, 3 cents; per pair, 21 cents. Regrinding old wheels on the axle, average for labor, 22 cents; emery wheel worn away, 6 cents; per pair, 28 cents. And these wheels, when ground, are just as true as any pair of steel-tired wheels ever turned out of a lathe.

Reference again to the report of the Committee on Brakeshoe Tests shows that the friction and loss of metal, where soft steel shoes were used on steel tires, was far greater than when soft steel shoes were used on cast-iron wheels. The inference is perfectly plain that on curves the rail wear from the flanges of steel-tired wheels will be greater than from chilled iron wheels, making a harder pulling train, and necessitating more frequent renewals of rails, which are expensive.

Having touched on the question of safety, weight, running qualities and rail wear, let us look at the very important question of first and final cost.

A really first-class chilled wheel, cast in contracting chills, can be produced from high-grade materials, including royalties, at a foundry cost of \$4.60 each, or, say, at a selling price of \$5 each. For a pair of such, \$10; add for cost of grinding true, 21 cents; cost of wheels when mounted, exclusive of axle and cost of boring, \$10.21 per pair.

We do not seem to be able to buy a really first-class article in the way of a steel-tired wheel for much under \$50 each, although some that promise well are offered at (turned) \$40 each; two such, \$80. Difference in favor of the ground cast wheels, \$30.79 per pair; for an eight-wheel car this is \$279.16 per car; for a 12-wheel car, \$419.74 per car.

A reputable firm of steel wheel makers guarantee their wheels (costing \$50 each new) for 260,000 miles; the M. C. B. guarantee for chilled wheels under the same service is 60,000 miles.

The steel-tired wheels will average $3\frac{1}{2}$ turnings to make the 260,000 miles. First cost of a pair of steel-tired wheels, say \$80; cost of $3\frac{1}{2}$ turnings, shop handling and machine work, \$5.25; cost of $3\frac{1}{2}$ removals and replacements at 60 cents, \$2.10; total, \$87.35. Deduct value of scrap, say 1,108 pounds at \$8 and \$10 per ton of 2,240 pounds, \$4.04; cost per pair of steel-tired wheels for 260,000 miles, \$82.41, exclusive of interest account; 260,000 miles represents about eight years and eight months' average service.

Assuming from the above that we would need to use $4\frac{1}{2}$ pair of chilled wheels to make 260,000 miles, we have cost of $4\frac{1}{2}$ pair of chilled wheels ground, \$43.91; cost of $4\frac{1}{2}$ replacements at 60 cents, \$2.60; total, \$46.51. Value of scrap, say 3,120 pounds, at \$10 per ton of 2,240 pounds, \$22.41. Cost of chilled wheels to run 260,000 miles, \$24.10, a difference in favor of the chilled wheels per pair at the end of 260,000 miles, say \$53.81.

Assuming that there are, as before mentioned, 34,000 passenger equipment cars in constant service, and making allowance for the number of six-wheel trucks under a portion of them, the difference in the amount of money invested in the one item of first cost of wheels alone would amount to about \$1,863,540; and this does not include the extra cost of stock wheels, machinery, etc.

Reviewing all the above arguments which, while not pretending to absolute accuracy in some respects, are as correct as necessary, it seems proper to draw the conclusion that a really first-class 60-pound 33-inch chilled wheel, ground true, costing perhaps 30 cents to 50 cents more than an average wheel, bought on rigid test and guarantee, especially marked and reserved for passenger service, is good enough for ordinary United States railroading.

It would be hard to find any more elegant examples of the printers' and engravers' art than in the souvenir numbers of the *Street Railway Review* and the *Street Railway Journal*, both issued last month on the occasion of the convention of the American Street Railway Association at St. Louis. And when we say that the reading matter is as interesting as the press-work is good, we can add nothing in way of praise.

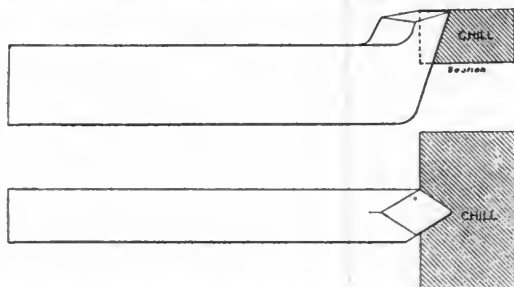
An important feature of *Harper's Magazine* for several months to come will be Poultney Bigelow's series of papers on the "White Man's Africa," treating in the author's original and striking way the new continent recently opened up to European exploitation. The first paper, in the November number, will give a novel view of Jameson's raid, from material placed in the author's hands by an English physician and a Boer official—thus presenting both sides of this remarkable episode. The series is the result of a journey to South Africa undertaken by Mr. Bigelow for *Harper's Magazine*, and is to be illustrated from photographs specially made for the purpose.

Cast-Iron Tools.

The illustrations and description of the cast-iron tools published in the October number appear to have interested so many persons that it is thought a description of the way they are made will not be out of place. They are cast from the ordinary wheel iron used in the Altoona foundry for making car wheels. The composition of this is from 30 to 35 per cent. of charcoal iron, 15 per cent. of coke iron, 5 per cent. of steel, and the balance old wheels made in the Altoona foundry. The coke iron is No. 2 foundry, and the specifications are that the silicon in it shall not exceed from 1 to 1.25 per cent.

The tools are cast from wooden or metal pattern, and of any form required. The chill or chill mold consists of a block of cast iron about one inch thick, and for a tool whose body is 1 by 1½ inches the chill is about 2 by 3 inches. This is notched out to the form of the point of the tool as shown in the illustration herewith, and is placed in the sand in the position in which it shown. The tools are cast with the point up, but the flasks are tipped up at the back end or heel of the tool so that the iron will be sure to fill out the point before it becomes cooled.

On inquiry, we found that these tools are not used in the wheel shops for turning axles nor for steel tires. One reason given is that they are liable to break under the set-screw, when fastened in the tool post. This difficulty may be overcome by putting a heavy piece of steel above or below the tool, before it is screwed



fast. One of the men using these tools informed the writer that he can do considerable more work with them for the reason that the work can be run at a higher speed, as they do not lose their temper or hardness by being heated, and that they can be heated red hot without being spoiled. There is no danger, either, of drawing the temper in grinding them on an emery wheel, as there is with steel tools. Surely, these are great advantages. They are, however, not suited for smooth-finishing cuts, as they will not hold a sharp cutting edge. As stated in our preceding article, they are used in lathes, planers and boring machines.

While in the toolroom, a cylindrical milling tool, 5 inches in diameter by 9 inches long, was shown to the writer, which was made out of an old steel axle and case-hardened. It had done a very large amount of service and had been brought in to be re-ground or sharpened.

M. C. B. Lithographs and Standards.

Lithograph copies of the drawings of Standards (sheets M. C. B., 1 to 12, inclusive) and Recommended Practice (sheets M. C. B., A to E, inclusive), illustrated on a reduced scale by 17 sheets in the back of the Report of Proceedings for 1896, may be had on a similar number of sheets, 30 by 38 inches, by applying to the Secretary at 974 Rookery Building, Chicago, Ill. Blue-prints can be taken from these sheets. The sheets will be sold at 25 cents each, plus postage when sent by mail. If needed for blue-printing, they should be shipped by express, and orders should specify by what express company they should be shipped.

Blue-print copies, 30 by 38 inches, of the drawings of Recommended Practice (see plates C, D, E, F and G in back of Proceedings for 1896), regarding axle and journal-box and contained parts for cars of 30,000 pounds capacity, may be had by applying to the Secretary, same address as above. These blue-prints will be sold at cost, which we now estimate will be about 30 cents each.

Pamphlets containing the text of the Standards and Recommended Practice, same as printed in the Proceedings of 1896, will be furnished similarly at 25 cents each.

Rulings of the Arbitration Committee.

When the Rules of Interchange were revised in June, 1896, the Arbitration Committee was authorized by motion to make a ruling on questions arising and not settled by the Rules, which ruling should stand thereafter as part of the Rules for the year. The following subjects which have been brought to the attention of the committee at its meeting, Sept. 16, by numerous parties, have been considered worthy of such ruling:

A. Because of the postal authorities becoming more strict in regard to the railway service mail, it has been suggested to the Arbitration Committee that the repair card stubs, referred to in Section 16 of Rule 4, might be allowed to accompany the bills instead of being forwarded to the car owner on or before the twentieth day of each month. The Arbitration Committee sees no objection to the suggestion being followed unless some car owner insists that Section 16, Rule 4, be literally complied with.

B. Section 25 of Rule 5 is intended to protect car owners from loss by reason of damage done in switching cars, therefore switching roads are not allowed to render any bills for damage caused while cars are in their possession. It is not intended to prevent switching roads from rendering bills against their immediate connections for any repairs of owner's defects which may be authorized by such connections when delivering the cars, and which existed upon the cars at the time of delivery. In such cases the delivering road must pay the bills of the switching road, and can only recover from car owners by certification on bills rendered by delivering road against the owner, that these owner's defects existed before the cars were delivered to the switching road.

C. Under the head of defects of wheels, a portion of Section (d) of Rule 3 of the Rules for 1895, has been inadvertently omitted from the Rules for 1896, and the following should be considered as a part of Rule 3, under the head of "Owners Responsible":

"Worn flange; flanges having flat vertical surfaces extending more than one inch from tread."

D. No provision is made in the Rules of Interchange as to scrap credit for old brakeshoes removed, and no provision is made for labor charges in renewing brakeshoes. The Arbitration Committee, therefore, recommends that no credit be allowed for the scrap in such cases, and that no charge be made for the labor of renewing the shoes.

THE MOST ADVANTAGEOUS DIMENSIONS FOR LOCOMOTIVE EXHAUST PIPES AND SMOKESTACKS.*

BY INSPECTOR TROSKE.

(Continued from Page 27.3)

X.—EXPERIMENTS WITH DIFFERENT SHAPES OF NOZZLES.

The experiments made with nozzles of the same opening, but of different inclinations and shapes, as shown in Fig. 68, gave no ground for thinking that the inclination of the conical sides of the nozzle or the overlapping form of the mouth exerts any noteworthy influence upon the action of the exhaust.

Prussmann's assertion, that the shape of the stack is dependent upon the inclination of the nozzle, here finds its refutation.

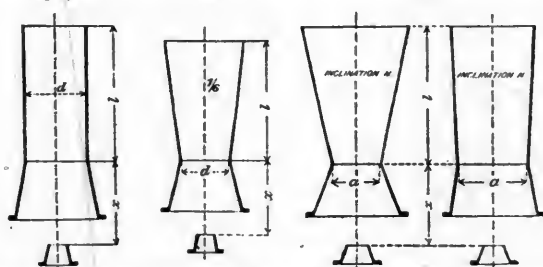
CONCLUSIONS.

The foregoing exposition and detail of experiments shows that

Fig. 69.

Fig. 70.

Fig. 71.



the action of a cylindrical stack upon the draft is dependent upon the inter-relationship of its size, that is to say, its free diameter d .

* Paper read before the German Society of Mechanical Engineers, and published in *Glasers Annalen für Gewerbe und Bautechnik*.

its length l , and the distance x , from the nozzle (see Fig. 69), and also upon dx .

If we change any one of these three dimensions in a stack the draft will also be changed. But by making a correlative change in the other two dimensions the new stack can be so designed that the same draft will be produced. Thus we can still retain a stack that will produce the same draft by making combinations with d , l and x .

The following cases are possible:

	Unchanged.	Changed.
1.....	d	dx
2.....	l	dx
3.....	x	dx
4.....	nothing	d, l, x

making four different forms.

In the conical stack as shown in Fig. 70, there must be added to the three preceding dimensions a fourth, or the flare ($\frac{1}{n}$) of that portion of the stack lying above the point of smallest cross-section, which thus makes the following combinations possible:

- (1) Six combinations of twos;
- (2) Four " " threes;
- (3) One " " four;

thus making in all eleven forms.

The combinations of two are as follows:

	Unchanged.	Changed.
1.....	dn	dx
2.....	dl	dx
3.....	dx	dn
4.....	dx	dl
5.....	nl	dx
6.....	nx	dl
7.....	lx	dn

The two forms that correspond to the original and combination 6 are given as an example in Fig. 71.

The combinations of threes are as follows:

	Unchanged.	Changed.
1.....	d	nlx
2.....	l	dxn
3.....	x	dxn
4.....	nl	dx
5.....	nx	dl
6.....	lx	dn

In the combination of fours the whole four elements must be changed.

Naturally, in place of the shape given in the groups others may be used, since for any single dimension different values may be assumed; for example, in the combination of twos the value for the flare in No. 6 may be $\frac{1}{2}, \frac{1}{3}, \frac{1}{4}$, etc., corresponding to the diameter of the waist. The same course can be taken with the length l , the nozzle distance x , etc. We can see that a given vacuum can be obtained with a number of different shapes of stacks.

This is, consequently, not in harmony with the opinion expressed by Clark (to be sure, it referred to cylindrical stacks only); that, "for a given locomotive there was but one form of stack in which the efficiency would be greatest, but in spite of the fact that Noz. and Geoffroy corroborated him and Zeuner and Prussmann applied the same principle to conical stacks we are confirmed in the opinion that:

On any locomotive with a given diameter of nozzle the same height of vacuum can be maintained with different stacks; the form itself, whether cylindrical or conical, being a matter of no importance.

The stack which will give the best results from the standpoints of the blowing of the fire and the consumption of coal cannot be determined either theoretically or by experiments with the apparatus; and here actual service on the locomotives must step in and play its part. This alone can tell us what stack will cause the fire to burn most evenly and quietly and give the smallest production of cinders and sparks. In general, a large stack is to be preferred to a small one for the production of a given draft, since with it, as we have already shown, the sides of the smokebox and the tubes remain cleaner, and also because it appears to be less sensitive in its influence upon the draft for slight changes in the position of the nozzle than is the case with smaller stacks.

In order to show the relative equality of the conical and cylindrical stacks in reference to their influence upon the draft, as well as the necessary differences in diameter the accompanying Table XXVII., based upon the curves given in Plate I., has been drawn up. It comprises those stack diameters, which, with nozzle distances ranging from 18.9 inches to 26 inches and the five different nozzle diameters (3.94 inches to 5.51 inches), produce the same vacuum of from 3.35 inches to 3.94 inches of water with a pressure of 3.94 inches of mercury in the experimental apparatus.

TABLE XXVII.

Vacuum in inches of water.	Nozzle distance and shape of stack.	Smallest diameter of stack in inches which, with the same nozzle distance on the experimental apparatus, will produce the vacuum indicated with a nozzle diameter of				
		Inches.	3.94 in.	4.33 in.	4.74 in.	5.12 in.
3.35.....	18 90.....	13.00	13.90	14.80	15.43	15.83
	cylindrical.....	14.53	15.36	16.26	16.73	17.13
3.54.....	20 47.....	15.98	17.01	17.99	18.50	19.00
	cylindrical.....	12.91	13.82	14.76	15.36	15.75
3.74.....	22.05.....	14.33	15.30	16.06	16.58	16.97
	cylindrical.....	15.51	16.58	17.60	18.07	18.47
3.94.....	23.62.....	12.81	13.78	14.69	15.28	15.67
	cylindrical.....	14.10	15.10	15.91	16.42	16.81
3.94.....	23.62.....	14.92	16.10	17.13	17.64	18.03
	cylindrical.....	12.76	13.70	14.65	15.24	15.63
3.94.....	23.62.....	13.86	14.76	15.75	16.26	16.65
	cylindrical.....	14.21	15.55	16.69	17.20	17.48

From this we may obtain for example the equivalent stack diameter of 4.33 inches and a distance of 20.47 inches and find them to be:

For the cylindrical..... 16.58 inches.
For the conical with 1 flare..... 13.82 inches.
For the conical with $\frac{1}{2}$ flare..... 15.20 inches

The table shows that the cylindrical stack for experiments on the apparatus, or the basis of this relationship, according to the nozzle distance required and the vacuum to be produced must, in this instance, be made 2.76 inches larger than the waist of a stack with $\frac{1}{2}$ flare and 1.38 inches larger than that with a flare of $\frac{1}{2}$. Hence we conclude:

The less a stack opens out toward the top, by just so much more, for the same length, must its smallest diameter be made, if a draft of the same intensity is to be maintained.

If, therefore, it is desired to apply a stack to a locomotive that shall have the same effect upon the draft, but whose flare shall be different, while the length remains the same, the size of the diameter must vary and, inversely, if the diameter of the smallest section is to be left unchanged there must be a variation of the length.

For the sake of a practical demonstration a four-coupled eight-wheeled Erfurt express locomotive was tested with the same nozzle ratios and stacks of different diameters and flares as well as with cylindrical stacks of 15.75 inches and 13.7 inches in diameter. The length l was made to vary 23.62 inches and the diameter of the waist by 3.94 inches. They all steamed very well and permitted a heavily laden fast train to be hauled promptly on schedule time. The coal consumption and the production of sparks was naturally different. Accurate measurements showed that the cylindrical stack was large enough and yet it was no larger than the conical and was even smaller. Experiments were also made with cylindrical stacks on a locomotive of another make. Everything went to confirm the first results obtained on the apparatus, namely:

The conical stack is in no way superior to the cylindrical.

If Zenner and Grove arrive at a theoretical conclusion the opposite of this, it may be remarked that in their principal equation referring to it:

$$\frac{L}{D} \sqrt{\frac{fs}{fb} - c} = \mu \left(\frac{fs}{fr} \right)^2 + c$$

the value of c , which expresses the conicity and shape of the stack, and is,

$$c = \frac{1 + \left(\frac{fs}{fa} \right)^2}{2}$$

was an entirely mistaken one by them, owing to the lack of experimental data at that time.

In both of these equations:

L = the quantity of air, which is drawn in by

D = the quantity of steam blowing out of the nozzle.

fs = the smallest sectional area of the stack.

fa = "largest " " " "

fb = "sectional area of the nozzle.

fr = " " " " tube.

μ = a coefficient.

Both of these theoretical investigators now deduce from the foregoing formula:

The draft-producing efficiency of a stack increases as c becomes smaller; that is correct. But they also conclude c will be largest (fs remaining unchanged), for $fa = fs$, that is to say, for cylindrical

cal stacks, and then $c = 1$; c will be smaller as fa increases, and it will be smallest ($= \frac{1}{2}$) for $fa = \infty$, that is to say for a stack the top of which has been widened out into infinity; from which it must be concluded that the more the stack widens out toward the top, by just that much will the effect upon the draft be more efficient. But this latter position is, as we have already shown, utterly untenable.

According to the Hanover experiments, as shown in Section VI., we find, on the contrary, the opposite to be the case, that is to say:

The smallest cross section of a stack remaining the same, the sharper a stack flares open toward the top (see Fig. 72) the less will be its effective action upon the draft.

Hence the foregoing equation:

$$C = \frac{1 + \left(\frac{fs}{fa} \right)^2}{2}$$

should be understood as follows: It is not fs but rather fa that must remain unchanged. Then the smaller fs becomes relatively to fa , by just so much will C also become less, and the effective action upon the draft increased.

The smallest value of C corresponds to $fs = 0$, in which $C = \frac{1}{2}$, in accordance with the reasonings of Zeuner and Grove; but it has merely a theoretical significance.

When $fs = fa$ (a cylindrical stack) the maximum value of $c = 1$ is that at which the smallest value is obtained for the vacuum.

When $fs < fa$ (a conical stack) the result is a lower value for c and a greater one for L .

This corresponds exactly with the results of the Hanover experiments (Section VI. b) which showed:

The upper diameter of a stack remaining thus unchanged, the

FIG. 72

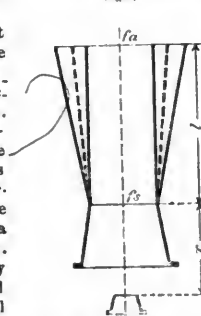


FIG. 73

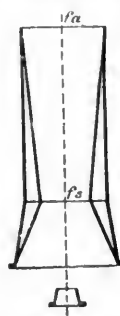
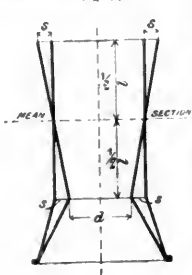


FIG. 74



sharper a stack contracts towards the bottom (see Fig. 73) by just so much, other conditions being the same, does the vacuum increase, in other words: With the same diameter at the top the cylindrical stack is least effective as a draft producer.

If the conical stack of Fig. 73 had the correct dimensions, the cylindrical stack of this figure for the same locomotive would naturally be too large, the nozzle relations remaining unchanged. If, on the other hand, the dimensions of the cylindrical stack were correct, then the conical stack that is indicated would be too small.

The above formula is therefore not available for making a comparison between conical and cylindrical stacks, and the many deductions made from it are unreliable. It simply asserts that generally a small stack produces a higher vacuum than a large one. The length of the stack and the position of the nozzle are not taken into consideration. Suppose a cylindrical stack with a sectional area fa (Fig. 73) produces too small a vacuum, the difficulty can be remedied without any change in the nozzle position, either by using a conical stack with a sectional area fa at the top, and whose smallest sectional area $fs < fa$, or by using a smaller cylindrical stack whose sectional area lies between fs and fa .

If it is desired to replace a cylindrical stack by a conical one, while the nozzle position and the draft is kept the same, it will be necessary, according to the experiments made on the four-coupled express locomotive, to keep the average sectional area of the two stacks the same; that is to say, we must make the upper diameter as much larger as the lower is contracted, as shown in Fig. 74. This, is, of course, on the supposition that the length above the base of the stack is to have a constant value l , which is the proper one for the sectional area of the tubes and the grate of the locomotive, and also with reference to d , as will be further explained later on.

As we have already explained, the experimental cylindrical stack

with a length of 3 feet 4.02 inches under fixed relations is 3.19 inches larger in diameter than the waist of the stack, having a flare of $\frac{1}{4}$. This difference, according to the last table, becomes less the higher the vacuum; while, on the other hand, it increases as the nozzle distance is decreased, the height of the vacuum remaining the same.

Suppose we take, for example, a difference of 3.15 inches (80 millimeters), then, according to the comparison made below, with $V = 3$ feet, 1.80 inch, the stack with a flare of one-sixth must be 3.15 inches, and that with one-eighth flare must be 2.36 inches smaller at the waist than a cylindrical stack of the same length V . Referring to figure 74, the size of s then becomes for

Stack with one-sixth flare = 1.575 inches.
 " " one-eighth " = 1.18 "

In consequence of the foregoing equivalence of the cylindrical and conical stacks, the rule which has, up to this time, been accepted as correct, according to which a conical stack requires a larger blast-nozzle than a properly designed cylindrical stack, this rule, we say, has no longer any basis of support.

Both forms of stack, if properly designed, need the same diameter of nozzle for the production of the same draft.

Practical tests were made of this proposition on two standard express locomotives, with four wheels coupled, as well as on several compound and ordinary freight locomotives, and also on several tank locomotives, and in all cases the conical stack was replaced by the cylindrical without any contraction of the nozzle.

The steam production, the formation of sparks, the coal consumption, etc., was such, during a long run in actual service, that the drivers who were in charge were so well satisfied with the results that they never expressed a wish during the whole time to have the conical stack replaced.

XII. THE RULES OBTAINED.

The Grove rules* for the determination of the stack diameters depends entirely upon the sectional area of the tubes and ignores the grate area. This method of calculation was accurate for the locomotives of that time, but it is not applicable to the locomotives of to-day with their large grate areas. The stack diameters must rather be based upon both of these dimensions, as Clark has already pointed out in his time. As we well know, the ratio of heating surface to grate area varies considerably in practice.

Long boilers of the same or of similar construction frequently have different sizes of fireboxes, so that, in such cases with the same number and size of tubes, the grate areas may be of very different sizes. Hence, if it were allowable to settle the size of the stack with reference to the sectional area of the tubes only, locomotives, which might have widely different grate areas, would still have the same size of stack with the same nozzle opening. But this is practically unallowable, for it has been shown in locomotive service that large grate areas, under exactly the same conditions, need a lower vacuum and a larger stack than the smaller grate areas.†

The rules for the determination of the size of the stack must, therefore, take the grate area into consideration. *There are two ways in which this can be done:* Either we can calculate the diameter of the nozzle opening from the given sectional area of the tubes and the grate area, and then from this, by means of a corresponding ratio, determine the diameter of the stack, or we can calculate the latter directly from the grate area and the sectional area of the tubes, and then derive from it the proper diameter of the nozzle that is to be used. Both methods lead us to the same goal, but we prefer the latter.

For the sake of simplicity we show the method with which the grate area is taken into consideration and how a different value must be given to the co-efficient according to its size and which expresses the relationship existing between the sectional area of the stack and the tubes that must also be taken into account in the calculation. For example, suppose the grate area increase from 9.76 square feet (one square meter) to 26.9 square feet (2.5 square meters, this co-efficient, according to the experiments that have been made) rises from nearly .34 to .375 for conical stacks having a flare of one-sixth, while for cylindrical stacks it rises from .505 to .5625.

(To be continued.)

* The rule for hard coal firing is:

Sectional area of cylindrical stack = $50fs$.

" " waist of conical stack = $33fs$.

Nozzle diameter for cylindrical stack = $\frac{1}{2}fs$.

" " conical stack = $\frac{1}{2}fs$.

When fs indicate the sectional area of the tubes.

The flare of the conical stack equal $s_{\frac{1}{6}}$.

† A four-coupled compound locomotive of the Prussian State Railway, having a grate area of 24.4 square feet would, while hauling a heavy freight train weighing 183 gross tons at a speed of 50 miles per hour, maintain a vacuum of from 3.15 inches to 3.54 inches of water while cutting off at .43 of the stroke,

The Moskowitz System of Electric Car Lighting.

The National Electric Car Lighting Company, of New York, has a car on the Pennsylvania Railroad equipped with the Moskowitz system of car lighting, the patents on which are controlled by them, and is about to equip a chair car on the Santa Fe road for service between Chicago and Kansas City.

The system is an electric one in which the current is obtained from a dynamo driven from the axle. In the standard equipment of the company a 21-inch wooden split pulley is clamped onto the axle, and this is belted to a 7-inch pulley on a countershaft secured to the face of the truck transom. This countershaft is supported on "spring-cushioned" bearings, or bearings on which springs act in such a manner as to keep the belt tight when the journal boxes move up or down in the pedestals. From the countershaft another belt runs over an 8-inch pulley to a 4-inch pulley on the armature shaft of the dynamo, the latter being secured to the end piece of the truck frame. The split pulley is of specially prepared hard wood; the belts are double thickness, the one between the axle and countershaft being 6 inches wide and the other 3 inches, and both belts are specially prepared with a view of withstanding all sorts of weather, including snow and ice; the dynamo is encased in a steel cylinder that is dust and water proof, and all bearings are of durable metal and automatically oiled from cups or reservoirs that will hold a week's supply of lubricant. The dynamo weighs 300 pounds, the split pulley on the axle 35 pounds, and the countershaft complete 80 pounds.

The dynamo is so wound that it maintains a practically constant voltage at all speeds above eight miles per hour, there being an increase of only three volts between this speed and 60 miles per hour. The poles are automatically reversed with each reversal of the direction in which the car moves, this being accomplished by devices on the switchboard.

The dynamo does not generate electricity at speeds below eight miles per hour, and to keep the lights going at times when the car is standing or running slow, two sets of storage batteries are provided, one set charged and ready to be automatically thrown into the light circuit when the speed falls below eight miles per hour, and the other being charged by surplus current generated by the dynamo. When fully charged the second battery is switched into the light circuit and the first one is connected to the dynamo for recharging.

The standard equipment for a 60-foot passenger car consists of sixteen 16-candle-power lamps, twelve in the body of the car and one in each vestibule. The current is taken from the dynamos on the truck by flexible connections to the car body and thence to a switchboard located at any convenient point, preferably in one of the closets in the car. The board is boxed up and can be put under lock and key if desired. On the switchboard are grouped all the devices by which the entire apparatus is controlled. First, there is the main switch, which controls all the dynamo circuits and which must be closed in order that the dynamo may generate a current. An ammeter shows the quantity of current generated and a resistance coil is provided to be switched into the light circuit if needed. Then there are the automatic electro-magnetic devices for reversing the polarity in the dynamo, already mentioned. There is also a special 12-point switch which controls the whole system. It is connected with the two sets of storage batteries already mentioned. While one of these batteries is furnishing light the other is being charged from the dynamo. When the battery that is furnishing the light is exhausted, the switch is thrown to the opposite position, and thereby connects the battery that has just been charged with the lights, while the other is connected with the dynamo to be charged again. One turn of the switch accomplishes the two changes, and it is impossible to make a mistake.

The storage batteries are carried in two wooden boxes under the car, and it is claimed that they require looking after only once in several months.

It will thus be seen that the system comprises the dynamo, two sets of storage batteries, a light circuit, and a switchboard. A car is supposed to start after installation of the system with its batteries charged sufficiently for six hours' light, and should then have current at all times for lighting purposes.

The chief claims made for the system are: A high grade of efficiency at moderate first cost, simplicity of design, ease of inspection, small operating expense, and the possibility of employing unskilled labor for attendance. The simplicity of operation is evident when it is considered that there are but two switches to operate, one throwing the dynamo into or out of service, and the other changing the connections to the batteries. All other features are automatic.

The National Electric Car Lighting Company has offices at 30 Broad street, New York City.

New Publications.

THE CHICAGO MAIN DRAINAGE CHANNEL. A description of the Machinery Used and Methods of Work Adopted in excavating the 28-mile Drainage Canal from Chicago to Lockport, Ill. By Chas. S. Hill, C. E., Associate Editor *Engineering News*. The Engineering News Publishing Company, New York, 1896. 129 pp., 8 inches by 11 inches.

The drainage canal which the city of Chicago is constructing is one of the greatest works of its kind in the world, and the policy of letting the excavation of the 40,000,000 cubic yards of earth and rock in small sections, combined with the variety of the materials to be excavated, has resulted in the employment of many methods for handling the material. Engineers expert in this kind of work have everywhere praised many of the methods devised and employed successfully by contractors who previously had little actual practice in canal work. Hence the volume before us is of special interest and value, for it describes and illustrates the methods and machinery employed. The cost of excavation are also given whenever obtainable, and while contractors would not in all cases furnish cost figures, the author believes that this volume contains more complete figures of the work than exist anywhere outside of the official records of the canal engineers. The book contains 100 excellent engravings and is written in a clear and concise style. It is a reprint of a series of articles which appeared in *Engineering News* last year, but numerous additions and revisions bring the work up to date. In an appendix the effect of the completed canal on the lake levels is fully discussed. We heartily commend the book to the attention of our readers.

LOCOMOTIVE MECHANISM AND ENGINEERING. With an Appendix on the modern electric locomotive. By H. C. Reagan, Jr., Locomotive Engineer. Second edition. John Wiley & Sons, New York. Chapman & Hall, Limited, London. 1896. 419 pages. 5 inches by 7 inches.

This book undoubtedly contains information of value to locomotive engineers and firemen, but the style of the author is far from clear, and what he says, if taken literally, would sometimes be misleading and even absurd. For instance, on page 2 he says: "That portion of boiler which is over the firebox must be very strongly stayed with either crown bars or radial stays. . . . This staying is necessary from the large area and the exposure to the hottest part of the fire." Neither of these reasons is true. Certain parts of boilers are stayed because their shape or form is such as to require it. On page 5 is the following: "It is important that all gage-cocks should be kept open and especially, under all circumstances, the lower one." What the author evidently means is that gage-cocks should not be allowed to become clogged up, but he does not say so. On the contrary, he appears at first sight to advocate the practice of running an engine with the gage-cocks wide open. On the same page the explanation of why the use of wet steam should be avoided could be considerably improved in clearness and accuracy. We might quote many other cases of bad English, such as where the author calls pistons "round disks," etc., and of misstatements, such as where it is said on page 73 that "cushion" in a cylinder is required "to prevent the piston head from striking the cylinder head"; but it is not necessary to go through its 419 pages to indicate the character of the work. In general, it may be said that the author appears to have a good fund of practical knowledge, but he is not sufficiently grounded in the principles of locomotive engineering to be always accurate; and furthermore, that his command of language is not sufficient to enable him to say just what he means in all cases.

EXPERIMENTS UPON THE CONTRACTION OF THE LIQUID VEIN ISSUING FROM AN ORIFICE, AND UPON THE DISTRIBUTION OF VELOCITIES WITHIN IT. By H. Bzvin, Inspector Général des Ponts et Chaussées. Translated by John C. Trautwine, Jr. John Wiley & Sons, New York; Chapman & Hall, Limited, London, 1896. 64 pages, 5½ inches by 9 inches.

This book records the results of very accurate experiments made upon liquid veins by the author, at Dijon, beginning in 1890. The orifices were as follows: 1. Orifices in a vertical plane: Square orifice, 0.20 meter square (contraction complete); circular orifice, 0.20 meter in diameter (contraction complete); rectangular orifice, 0.80 meter wide by 0.20 meter high (lateral contraction suppressed). 2. Orifices in a horizontal plane: Circular orifice, 0.20 meter in diameter (contraction complete); circular orifice, 0.10 meter in diameter (contraction complete). The co-efficients of discharge, the geometrical figures of the veins and the velocities in the interiors of the veins, were determined for each of these orifices, under a head of 0.95 meters. Many valuable figures are given and the more important conclusions may be briefly stated as follows: The experi-

ments do not show the presence of a minimum section in the contracted vein. The vein contracts rapidly at first and then more slowly as its distance from the orifice increases. The minimum velocity at the orifice is at the center for orifices in a horizontal plane and a little above the center of gravity of the section for orifices in vertical planes. As the distance from the orifice increases the velocities in the flow from a horizontal circular orifice equalize rapidly; in the flow from a vertical orifice the minimum in the central region soon disappears, but the velocities in the lower part of the vein remain greater than those in the upper part. In the expression $U = K \sqrt{2gh + y}$, U representing the velocity and y the fall of the center of the section below that of the orifice, the co-efficient K is slightly less than unity for a horizontal orifice and more than unity for a vertical one. It might attain a value of 1.03 or 1.04 for vertical orifices.

The volume is a most valuable addition to the literature of hydraulics, and the reputation of the author is a guarantee of the accuracy of the work, for his name is already known to English-speaking engineers through his valuable experiments on the flow of water in open channels.

Trade Catalogues.

[In 1891 the Master Car-Builders' Association, for convenience in the filing and preservation of pamphlets, catalogues, specifications, etc., adopted a number of standard sizes. These are given here in order that the size of the publications of this kind, which are noticed under this head, may be compared with the standards, and it may be known whether they conform thereto.]

It seems very desirable that all trade catalogues published should conform to the standard sizes adopted by the Master Car-Builders' Association, and therefore in no listing catalogues hereafter it will be stated in brackets whether they are or are not of one of the standard sizes.]

LIST OF GEARING, PULLEYS, SHEAVES, ETC. Robert Poole & Son Company, Engineers and Founders, Baltimore, Md., U. S. A., 1896. 234 pages. 5 by 7½ inches. (Not standard size.)

As its title indicates, this book is a list of gears, pulleys, etc., for which the Robert Poole & Son Company have patterns, and which they can therefore furnish on short notice. The patterns are classified according to pitch and the tables give all the essential dimensions of each gear and pulley. The list includes spur, level and mitre gears of many sizes; mortise gears, spur, face and bevel; worms and worm gears; wheels for wire-rope transmission; sheaves for ropes and chains; band, rope and fly wheels; and pulleys for belt transmission. While the list of gears contains only the sizes for which the company has patterns, the system of machine-molding employed at their works enables them to make almost anything in the gear line of one inch pitch or over, with but little expense for preparation. The reputation of this company's machine-molded gears is thoroughly established and not the least of their merits is the excellent material put into them. The company's facilities enable them to make gears up to 50 feet in diameter. The company also has facilities for making cut gears of all kinds up to the same size. This concern makes the Poole-Leffel double-turbine water-wheel, patent friction clutches, shaft hangers, thrust bearings, etc., all of which are illustrated in this catalogue, though some of them are more fully described in other pamphlets issued by the company.

THE MOST ECONOMICAL BRAKESHOE. The Schoen Brakeshoe Company, Betz Building, Philadelphia, Pa. 8 pages. 6 by 9 inches. (Standard size.)

This pamphlet illustrates and sets forth the advantages of the pressed-steel brakeshoes made by the company. The tests of the brakeshoe committee of the Master Car Builders' Association are quoted to show that soft pressed-steel shoes rate very highly in their wearing qualities and holding power. They are claimed to wear 10 times longer than cast-iron shoes, to be capable of being worn thinner, thus giving more useful wearing material per shoe, to hold with a nearly uniform retarding power, to heat less rapidly than other shoes, to necessitate less frequent adjustment of the brakes, to wear the wheels less than cast-iron shoes, and to effect a saving of from 50 to 75 per cent. in the outlay required for brake-shoes. To substantiate these claims the company can point to the experience gained in three years of service. The shoes are made by hydraulic pressure by a process that permits the use of very soft steel, and the form and dimensions of the present standards are duplicated with great exactness.

WATERMAN'S IDEAL FOUNTAIN PEN. J. E. Waterman Company, 155-157 Broadway, New York. 16 pages. 5 by 6½ inches.

This catalogue illustrates the various sizes and styles in which this, the best of fountain pens, is made. It contains many testimonials as to its excellence, beginning with the opinion held by Mr. Chauncey M. Depew, who says: "I am still using your incomparable fountain pen. Since I bought my first one in July, 1886, it has been my constant and faithful companion." We would take this opportunity to add our testimony to that of others who have used this excellent pen. We have now used this pen for four years, and in all that time it has never failed us. It has always made its mark on the first stroke and given no trouble in feeding. To those who have had trouble with fountain pens that won't feed or that feed too much, we would advise a trial of the Waterman. With the most ordinary care they will be found always ready and will always write smoothly.

The Fourth Annual Report of the Michigan Peninsular Car Company.

The fourth annual report of the Michigan Peninsular Car Company, of Detroit, is an interesting document. This large concern, formed by a consolidation of several interests four years ago, has a plant comprised of two complete car-building establishments, one car-wheel foundry, a forge and iron works, and a pipe plant, the total valuation being \$7,720,536. The report shows that during the year the company spent \$24,478, in additions to its plant, and that its total assets on Aug. 31, 1896, was \$10,439,791.49. The preferred capital stock is \$5,000,000, common stock \$3,000,000 (of which \$1,000,000 is unissued) and there are first mortgage bonds to the extent of \$2,000,000.

During the year ending Aug. 31, 1896, the company paid the interest on the bonds and also dividends of \$200,000 on the preferred stock, and then had a surplus on the year's business of \$96,571.84. Like that of all other manufacturing concerns its business for the last four years shows great fluctuations. The figures prove, however, that the plant of the company can be operated with good profits when work is obtainable to keep it going, as is evident from the following statement of earnings from all sources for the four years commencing Sept. 1, 1892, and ending Aug. 31, 1896:

1st year	\$865,699.66
2d year	34,024.38
3d year	150,231.98
4th year	393,571.84
Total	\$1,158,517.86

During the first year of this period the company paid \$400,000 dividends (8 per cent.) on the preferred stock and \$100,000 on the common stock. Of course, with the depressed condition of business in the second and third years, the earnings did not suffice to pay the interest on the bonds, but in the last year dividends have been resumed and the company stands ready, with a large and efficient plant and considerably more than a quarter of a million surplus, to take advantage of the improvement in business to be expected after the election has given business men the assurance of a sound currency.

Graphite Paint for Metal Work

Engineers are giving much more attention now than formerly to the paints employed in the preservation of structural iron and steel from corrosion. Undoubtedly the large use of steel in fireproof buildings where it is not accessible after the buildings are complete has been an important factor in stirring up this interest. The protection of such surfaces from corrosion is certainly a matter of moment. It is of vital importance in the case of fireproof buildings, and in all structures a suitable protective coating is a source of economy. Roofs and bridges, while accessible for re-painting, are made more durable at less expense by a coating that is lasting and does its work thoroughly than by one that needs frequent renewal. In our article on steel cars in France, published in our August issue, it was shown that the protection of a good paint applied frequently enough to keep the surface covered at all times added many years to the life of the cars. And so many other cases might be cited which in part explain the present interest in protective paints for iron and steel.

The possible chemical action between the pigment and the oil, and its effect upon the surface it covers have been studied carefully and the opinion is now held that some paints actually promote oxidation of the metal. But however truly this may apply to some paints it is not true of all them, and those known as graphite paints are certainly free from any tendency to chemical action between their constituents, and show remarkable resistance to chemical action from without. "Superior" graphite paint manufactured by the Detroit Graphite Manufacturing Company, of Detroit, Michigan, has established itself in the confidence of engineers by the excellent record it has given in actual service. The graphite entering into this paint is mined by the company in Northern Michigan. Mixed with an oil and free from acids, it is chemically inert, and in drying forms a coat that adheres firmly to the metal surface. Its resistance to the action of acids and alkalis has been proven by numerous tests much more severe than the conditions of service, and its resistance to the penetration of moisture have been equally satisfactory. Heat does not cause it to blister, and we are informed that steel chimneys painted with it have been heated to redness without affecting the paint. The viaduct by which the Canadian Pacific and Wabash roads enter Detroit is painted with "Superior" graphite paint, and after two years service is still in excellent con-

dition. A fire in neighboring flour sheds played upon the iron-work for two and one-half hours without blistering the paint. This fact is attested by Mr. J. E. Smith, superintendent of terminals, who in the same letter also says that the smoke and fumes from Michigan Central locomotives, which pass under the viaduct at one point, have had no effect upon the paint.

The paint has been used with success upon the hulls and decks of steel steamers, and there seems to be no conditions of service which it does not successfully meet. Those who would use it in places where its natural color is undesirable, can have a choice of several colors and shades. The Detroit Graphite Manufacturing Company uses every care in the manufacture of the paint. The fineness of its particles give it excellent covering qualities and cause it to apply evenly.

A Commercial Travelers' Fair.

A commercial travelers' fair is to be held in Madison Square Garden, New York, Dec. 15 to 23. Its aim is to raise \$150,000 to complete the National Home for commercial travelers or their dependent families, at Binghamton, N. Y. It is the intention of those in charge to make the fair one of the best attractions of the year. Mayor George E. Green, of Binghamton, is President of the Commercial Travelers' Home Association, and is the Treasurer of the fair. Col. A. B. de Freese, Director-General of the fair, has proposed that upon Tuesday, Dec. 1, in every city of more than 10,000 inhabitants, the hotels, theatres and leading stores will devote a percentage of the day's receipts to the Fair Home building fund. Mr. Allen S. Williams has been elected Chairman of the Commercial Travelers' Day Committee. The Honorary Committee of the fair, which is presided over by the Hon. Chauncey M. Depew, comprises over 1,200 leading men in the United States, representing almost every principal locality important in traffic, producing or manufacturing. The only detail necessary to the perfect working of the plan for a Commercial Travelers' Day (which is to be a feature of the fair) is for the hotels, theaters and stores desiring to share in the philanthropy, honor and pecuniary benefit of the occasion to promptly notify Chairman Allen S. Williams at Madison Square Garden, New York, of their desire to remit the cash results on Dec. 2, in a New York bank draft payable to George E. Green, Treasurer, or to Director General A. B. de Freese at Madison Square Garden, New York.

Wm. Skinner & Son, of Baltimore, have received an order from the Baltimore & Ohio for 10 freight lighters for use in New York Harbor.

The American Brake Beam Company has orders for 4,000 Kewanee beams for the Erie cars being built by the Michigan-Peninsular Company.

The Niles Tool Works has an order from the Government for eight carriages for 10-inch disappearing guns. This equipment is for coast defense.

The Lidgerwood Manufacturing Company, 96 Liberty street, New York City, has opened a branch office at New Orleans in the Hennes Building, in charge of J. H. Dickinson.

The report that the plant of the Cambria Iron Company, at Johnstown, Pa., had closed for an indefinite period is denied. The plant resumed operations on the 12th of last month.

The West Shore Railroad has placed a contract with the Harlan & Hollingsworth Company, of Wilmington, Del., for a steel hull ferryboat for use on the North River. The boat is to be 250 feet long.

Mr. C. R. Brown, formerly with the Illinois Steel Company, has entered the Western department of the Lappin Brake Shoe Company, and has offices with Mr. F. P. Collier, the Western Manager for the company, in the Rookery Building, Chicago.

Prince Hilkooff, Russian Minister of Ways and Communication, who has been in this country studying American railroad operation, has sailed for Europe. It is said that before sailing he placed orders for 18,000 American watches for the use of the trainmen on Russian railways.

At the last meeting of the Board of Directors of the Bloomsburg Car Manufacturing Company, Bloomsburg, Pa., a change in the Presidency was made, Mr. G. M. Lockard having sold his interest

In the company to Mr. L. S. Wintersteen. The latter gentleman was made President. The works are at present busy filling orders for Japan and South America.

The Bloomsburg Manufacturing Company, Bloomsburg, Pa., had a part of its main building blown down in the severe storm of Oct. 1, and the roofs of the boiler-house and muffle-room carried away. Rebuilding and repairs were at once commenced and now the mill is in full operation.

The Shoenberger Steel Company, of Pittsburgh, has awarded contracts to the Ball Engine Company, Erie, Pa., and to the Siemens-Halske Electric Company, New York, for an electric power plant, consisting of one 400 and one 150 horse-power vertical compound engine, direct connected to 225 kilowatt and 100 kilowatt generators.

George P. Nichols and Brothers, 1325 Monadnock Building, Chicago, announce their appointment as general sales agents for the Western States of the J. H. McEwen Manufacturing Company, of Ridgway, Pa., manufacturers of the McEwen automatic engine, simple and compound; also the Thompson-Ryan generator for electric railway, power and lighting plants, belted and direct connected.

Messrs. Riehle Bros. Testing Machine Company have shipped to the Sormovo Co., Nijni Novgorod, Russia, a 100,000-pound automatic and autographic testing machine and also a specimen miller. They have also placed 200,000-pound testing machines at the works of the Schoen Pressed Steel Company and Jones & Laughlins, Pittsburgh. They are also building a large 300,000-pound wire rope testing machine for John A. Roebling's Sons Co., Trenton, N. J.

The American Stoker Company, of Dayton, O., has recently perfected a steam motor which is applied to each stoker, thus making each machine independent. This renders the work of installation very simple. It also renders the stoker practicable for use under Marine boilers. This company is desirous of a general representation through engineering firms handling pumps, heaters and boiler-room supplies, and invites correspondence from interested parties.

The Ingersoll-Sergeant Drill Co. have placed an air-compressor in the engine-room of the Havemeyer Building, New York City, and compressed air will be supplied to tenants in the building who desire it. The company's offices are in this building and it will employ air to operate appliances of all kinds on exhibition in its offices. This will include machinery, tools, letter-presses, etc., while the same agent will be used to dust the furniture, clean carpets, ring call-bells, open doors and in general display its usefulness and utility.

The Peerless Rubber Manufacturing Company of New York has added a 320 by 40 feet extension to its works. The building is three stories high and practically doubles the capacity of the plant. The capacity of the Peerless plant is now \$2,000,000 worth of mechanical rubber goods per annum. In the new factory are four 200 horse power of water tube boilers and one 500 horse power Corliss engine. Among other machinery it contains one of the largest belt presses in the world, it being 30 feet long, 60 inches wide, with double plates and double stretchers.

The Borden & Selleck Company, Lake street, Chicago, Ill., reports a fairly active business in its coal and ash handling machinery. Among plants recently put in operation are: Ash and soft coal handling conveyors for two power-houses of North Shore Electric Company (Chicago); soft coal conveyors, steel storage tanks, etc., for carrying coal from a side-track through a tunnel under street and factory, delivering same into battery of boilers, for Jas S. Kirk & Company, soap makers, Chicago. A contract has just been closed with the Chicago Public Library for anthracite coal and ash-handling machinery for the new library building.

Notwithstanding the dull times the New York Belting and Packing Company has within the last few weeks taken orders for interlocking rubber tiling for three prominent hotels in New York City, a well-known club in Cincinnati, 33 dining and sleeping cars, one steamship and one United States battleship. The first lot of tiling the company laid was in the Broad Street Depot of the Pennsylvania Railroad, in Philadelphia. After two and one-half years of wear, with an average of 50,000 people passing over it each day, the tiling has worn down only one-sixteenth inch, and that only in

spots where most of the travel is concentrated. Not a cent has been spent for repairs since it was laid. We saw this tiling less than a week ago and it was noticeable for its freshness of color and perfect condition generally. The tiling is remarkably pleasing in appearance when new and loses none of that attractiveness as it wears. It gives a good foothold, does not wear slippery, and, in fact, it retains all of its good qualities unimpaired throughout its life. It should be investigated by those who desire a durable and artistic covering for floors, stair landings, decks, etc.

Florida and Western North Carolina.

The climate is nearer perfection than that of any other place on earth. The time is fast approaching when numbers will desire to seek a milder climate. Where shall you go? The Southern Railway, "Piedmont Air Line," the great Southern trunk line, offers numerous attractive resorts located upon and reached by this great system of railways, all reached from New York in Pullman's finest vestibuled trains, giving all the comfort and conveniences that are required by the demand of the traveling public. If you are contemplating a trip and want descriptive literature or any information regarding the winter resorts South, call on or address General Eastern Office of the Southern Railway, 271 Broadway, New York.

Our Directory

OF OFFICIAL CHANGES IN OCTOBER.

We note the following changes of officers since our last issue. Information relative to such changes is solicited.

Altoona, Clearfield & Northern.—President F. G. Patterson has been appointed Receiver.

Brooklyn Beach.—Mr. E. L. Langford has been chosen President, vice J. Jourdan.

Chicago, St. Paul, Minneapolis & Omaha.—Mr. Walter A. Scott has been appointed General Manager, with office at St. Paul, vice Mr. H. G. Bent, resigned.

Chicago & Northwestern.—Mr. Horace G. Bent has been appointed Third Vice-President, vice Mr. W. H. Newman, resigned.

Charleston & Western Carolina.—This corporation is the successor of the Port Royal & Augusta.

Interoceanic of Mexico.—Mr. G. M. Stewart has been appointed General Manager.

Illinois Central.—Mr. F. W. Brazier has been appointed Assistant Superintendent of Motive Power, with office in Chicago.

Louisville, Evansville & St. Louis.—Mr. J. F. Lechler has resigned as Master Mechanic at Princeton, Ind., and is succeeded by Mr. F. C. Cleaver, Mr. W. W. Wentz, Jr., is Secretary and Purchasing Agent, with office at Louisville.

Minneapolis & St. Louis.—Mr. Edwin Hawley has been chosen President, to succeed Mr. W. L. Bull, resigned.

Missouri, Kansas & Texas.—Mr. J. L. Wight has been appointed Master Car Builder of lines north of Denison, with headquarters at Sedalia, Mo. Mr. W. H. Brehm has been appointed Master Mechanic over the same lines, with headquarters at Parsons, Kan.

Manitou Beach.—Mr. F. J. Sarnon, formerly Master Mechanic, has been made Superintendent, vice Mr. G. C. Mills. Mr. Chas Sarnon is appointed Master Mechanic.

Mexican National.—Mr. E. D. Stegall has been appointed Master Mechanic at Acambaro, Mex. Mr. E. W. Knapp, formerly at Acambaro, has been transferred to Mexico City.

Northampton & Hartford.—G. H. Clark, Jr., has been elected Vice-President, with office at Newark, N. J., vice A. L. Shepherd, deceased.

Norfolk & Western.—The Receivership was abolished Oct. 1. Mr. Henry Fink is President and Mr. F. J. Kimball Chairman of the Board of Directors.

New Orleans & Western.—Mr. W. Mason Smith has been chosen President, vice Mr. Chas. E. Levy, resigned. Mr. W. W. Pierce has been chosen Vice-President, vice Mr. W. Mason Smith.

Ogdensburg & Lake Champlain.—H. Walter Webb has been appointed Temporary Receiver.

Oregon Improvement.—Mr. L. H. Hawkins has been appointed Chief Engineer, with office at Seattle, Wash.

Pullman Palace Car Co.—Gen. Horace Porter, first Vice-President, has resigned, and is succeeded by Mr. G. H. Wickes, formerly second Vice-President.

Pittsburgh & Lake Erie.—Mr. J. A. Atwood has been appointed Chief Engineer.

Wheeling & Lake Erie.—Mr. W. H. Stark, Master Car Builder has resigned.

AMERICAN ENGINEER CAR BUILDER AND RAILROAD JOURNAL.

DECEMBER, 1896.

THE ALTOONA SHOPS OF THE PENNSYLVANIA RAILROAD.

VI.

(Continued from page 284.)

PIECE-WORK.

In nearly, or quite, all of the shops at Altoona, work is now done by piece-work, and almost all of it, even to such service as handling coal and ashes, cleaning the tubes of locomotives, washing windows, etc., has now been brought under that system. This was introduced at Altoona in a sort of rudimentary form as much as 25 years ago, and has been thoroughly tested and perfected since, and its great advantages have, it is thought by those who are in charge of the shops, been thoroughly demonstrated during that period, and they would as soon think of substituting the old hook valve-gear for the link-motion, or replacing injectors with pumps, or steel tires with those made of cast-iron, as of going back to the day-work system in their shops. Now, one of two things is certain, either those in charge of the machinery, the shops and the work at Altoona are very much deluded with reference to the advantages of that method of doing work, or those who are responsible for the management of other similar establishments are very blind in not adopting it, or, at least, acquainting themselves with the working and merits of that system.

It is claimed for it—and apparently on grounds which cannot be disputed—that it doubles the output of work from a given equipment and a given number of men. In proof of the latter it is said that in the old shops at Altoona, before work was done in this way, 50 new locomotives were built in a year. After piece-work was introduced 100 were built in the same time, with substantially the same tools and appliances and the same number of men. An equal increase has been made in the output of repair work in the locomotive and car shops.

As an illustration the following case was cited by one of the foremen: In 1880, in making the general repairs to locomotives, a gang of 32 men were employed for every three engines. By day-work it then took 28 days to rebuild three engines and the work in the erecting shop cost \$370 per engine. When piece-work was first introduced 14 men and 2 apprentices were employed to do the same work and it cost 20 per cent. less. Now this work is done by 9 men, 3 apprentices and 1 laborer in 14 days and the labor costs \$90 per engine.

In the construction of new engines the difference is equally as marked as in repair work. The cost of day's work in the erecting shops of what are known as class I engines was \$290. Engines of the same general class, but about 15 tons heavier, now cost \$95.75, and are done in half the time. Substantially the same equipment, such as traveling cranes was employed under both systems, although some appliances and methods for doing work economically were devised and adopted by the men and their foremen in order to facilitate and expedite what they were doing. By day's work it took three days to build a box-car; now it is done in 14 or 15 hours. The pipe-work on a locomotive formerly cost \$137, and now costs \$32.

In making up the schedule of prices for piece-work from the cost by the day's-work system a primary reduction of 25 per cent. was made. Since then other reductions in prices have followed, so that now, as has been stated, the cost of labor in the Pennsylvania shops has been reduced one-half, and the output of work by a given equipment and number of men has been doubled. If

these statements have any basis of fact to rest upon, they are surely worthy of serious consideration by those who control similar expenditures in other great enterprises.

Another advantage is that the men make a great deal more money, in a given time, under the piece-work system than they do when working by day work; they are more interested in what they are doing, become more efficient in their duties and are better content in their positions. No driving of the men is required, because if any of them are disposed to loiter or "loaf"—as expressed in workshop vernacular—the time thus wasted is their own loss. To a great extent they can enjoy the independence of controlling their own time, and none excepting those who have endured it know how irksome it becomes in time to be tied down to fixed hours and inexorable conditions of service.

Another effect of the system is that it stimulates the ingenuity of the men to devise new methods and appliances for doing and handling work. They resort to all kinds of expedients to facilitate what they have to do and increase their output. This was especially noticeable in the blacksmith shop at the car works. In modern car construction many forgings of more or less complicated forms are required. To make these a great variety of formers, dies, clamps, etc., are needed, and each man who is paid for the number of pieces he can make in a day is interested in devising new appliances which will facilitate the doing of his work. A very interesting book might be written describing the means employed in this shop and showing how the different kinds of forgings are made.

It also results in a complete differentiation of capacity. That is if a man has any kind of special skill or aptitude, he is employed only on work which requires such skill, while that which can be done by mechanics of a lower grade, or by ordinary laborers, is assigned to men of that class. In that way a process of specialization is instituted, which, to a great extent, becomes automatic in its action, so that each man does what he is best suited for. It also results in the speedy weeding out of the incapables and the unworthy.

If honestly and justly administered, it removes some of the chief causes of disputes between the men and their employers, and substitutes "sweet reasonableness" for contention and acrimony.

The first objection, which is made by those who have little or no knowledge or experience with the practical working of this system, is that it results in bad workmanship, and it is assumed that it is an utterly hopeless task to undertake to so classify all the multifarious operations required to repair locomotives or cars, as to be able to assign a fair price for each distinct operation. Some idea of the complexity of this task may be formed when it is said that in the locomotive erecting shops there are 180 separate items and prices for stripping an old engine and 360 for erecting it anew. Besides locomotive work considerable is done in this shop on signals, water-stations, etc., for all of which there are separate scales of prices, making about 1,000 items in this one shop. In all the locomotive repair shops there are probably from fifteen to twenty thousand distinct prices and at the car and Juniata shops as many more. Only about one per cent. of the work in the erecting shops is done by days work. In the boiler shops there is a price assigned for putting in stay-bolts; riveted work is counted at so much per rivet, caulking and flanging is paid at a given price per foot.

The following are some of the items taken at random from the schedule of prices in the boiler shops, the prices themselves being omitted:

PATCHING BOILERS AND FIREBOXES.

Putting in cheek patches and other small patches with less than 20 rivets, per rivet.....\$
For larger patches in boilers and fireboxes—for first 30 rivets, per rivet.....\$
All over 30 rivets in same patch, per rivet.....\$
Putting new bottom in smokebox 65 to 80 inches long.....\$

ASH-PAN REPAIRS.

General repairs to include new side sheets or sides straightened and patched, bottom straightened and patched, new shields, top and bottom, new collar pieces or collar straightened, one back plate, side pocket and lid straightened, new damper bearings.....\$
Ash-pan cleaned and painted, classes J, K, P and R, each.....\$
Flanging ash-pan collar.....\$
damper.....\$

and the cost of the time. This was repeated a sufficient number of times until it was certain that the average cost had been ascertained, and that the subdivision had been carried far enough to establish and apportion the prices for doing work. Those for piece-work were then fixed about 25 per cent. lower than the cost by day's work, and this schedule was then put in operation. It of course required a great deal of subsequent revision, which had to be done with the most conscientious care and intelligence, and with a disposition to deal fairly with both the men and the company. Prices had to be revised, and the classification changed whenever experience indicated it was required. This has been the work of years and the system still requires occasional revision. After piece-work had been adopted for some time, and the men had shown how much work they could do, further reductions in the prices were made, care being taken that by diligence the men could still earn more money than they would by day's work. It should be said here that each man is rated at a certain price per hour, at which rate he is paid when it is necessary to do time work, and an account is always kept of both the time occupied and the amount of work done, and his compensation is estimated in both ways to indicate whether the prices are excessive or too low. The following figures taken at random from a book in the boiler shop indicates the earnings of ten men for the month of June estimated in both ways. Of course they were paid piece-work prices:

Earnings estimated by day's work.	Earnings estimated by piece-work.	Earnings estimated by day's work.	Earnings estimated by piece-work.
\$45.25	\$53.81	\$20.76	\$24.72
39.82	47.41	22.26	26.50
20.76	24.72	24.78	29.50
35.40	42.14	31.40	40.96
15.12	18.00	20.52	24.44

During this period the shops were running short time, but it will be seen that the earnings of these men were considerably greater—nearly twenty per cent.—by piece-work than it would have been by day's work. Consequently piece-work is very popular with the workmen, and any proposal to abandon it and return to the system of day's work would be resisted and met with general disapproval and discontent.

Another cause of its popularity is the greater independence which it gives to the men. If any of them are suffering from malaria, lumbago or pain in the stomach, and is disinclined to work hard, it is his own affair. If disposed to condemn any pernicious political doctrines or candidates such as those advocated by the late Mr. Bryan, during working hours, a workman may do so without let or hindrance. It removes both the fact and the feeling of being driven by a taskmaster, and substitutes a sense of freedom for a feeling of servitude.

One of the results of the piece-work system, it is said, is that there are no trades-unions in Altoona, but there are many building associations and churches which are prosperous. The increased earnings of the men enables many of them to own their own houses.

One of the objections which have been made to piece work is that the men over-exert themselves and finally break down, and on this ground it has been often opposed by many of the trades-unions. This evil has appeared at times in the Altoona shops, but it is said can easily be checked. Of course, if those who are in control reduce prices too much, it will compel men to over-exertion in order to earn adequate wages, which leads to the reiteration of the statement that piece-work is practicable only where those in charge are disposed to deal fairly with those under their control, the moral of which is that geese which lay golden eggs should not be slaughtered.

Among the useful organizations at Altoona is a foremen's association, at which papers are read and discussed which relate to their various occupations and duties. At one of their meetings Mr. Thos. McKernan, General Foreman of Carpenters, read a paper in which he referred to one of the incidental disadvantages of the piece-work system which is worthy of consideration. It relates to that much-neglected individual, the apprentice. In the course of his observations Mr. McKernan said:

"That the piece-work system which has been established in the shops (though a very good thing in many ways) has a tendency to operate against the apprentice is manifest without explanation.

The foreman does not always do his duty by the apprentice: the boy is not seen for days, neither inquiry is made as to how he is getting along, nor encouragement given him. This is not right, but decidedly wrong; for there is a moral obligation that every foreman assumes as foreman, to teach the apprentice a trade, and the foreman should do his best for the boy. A modest, unassuming lad frequently becomes discouraged; matters do not go right and he does not like to ask the journeymen, for he might receive the answer, 'I have no time.' The apprentice wants the sympathy and encouragement of his foreman. The foreman should talk and sympathize with him, and reach his better nature, stirring in his soul a sense of confidence, infusing in his young mind new desires, and encouraging him to have a higher aim and a nobler ambition."

There certainly is much force in this statement. Those of us who can remember the bleak desolation of our early apprenticeship, the dreadful feeling of isolation and loneliness which comes to a boy when he is first cut loose from home and friends, will sympathize with Mr. McKernan's remarks. That the evil, though, is remediable seems plain. The piece-work system demands the services of inspectors of work; these might be delegated with the additional duties of instructors of apprentices. Piece-work probably fosters, to a greater or lesser extent, the principle of every man for himself and the devil take the hindmost. What seems to be needed is a kind of supplemental good angels to look after young apprentices. It should never be forgotten that these neglected people of to-day are those who stand behind us and will certainly slip into our shoes in that very near future when we will be expected to step down and out.

As an illustration of the educational influence of piece-work it was told the writer that it often happens that men are put to work in gangs in which each man is entitled to a certain percentage of the earnings of the gang. The mathematical knowledge of some of these men is often so limited that they do not know how to calculate their proportion of the earnings. It is said that under the stimulus of this system, in a very few months, the most ignorant men learn how to calculate percentages as well as the best of them.

Another amusing incident was related. When piece-work was first introduced into the locomotive shops the W. C. accommodations were considered insufficient for the number of men who used them, and it was intended to extend their precincts. After the new system it was found that they were ample and there was room to spare.

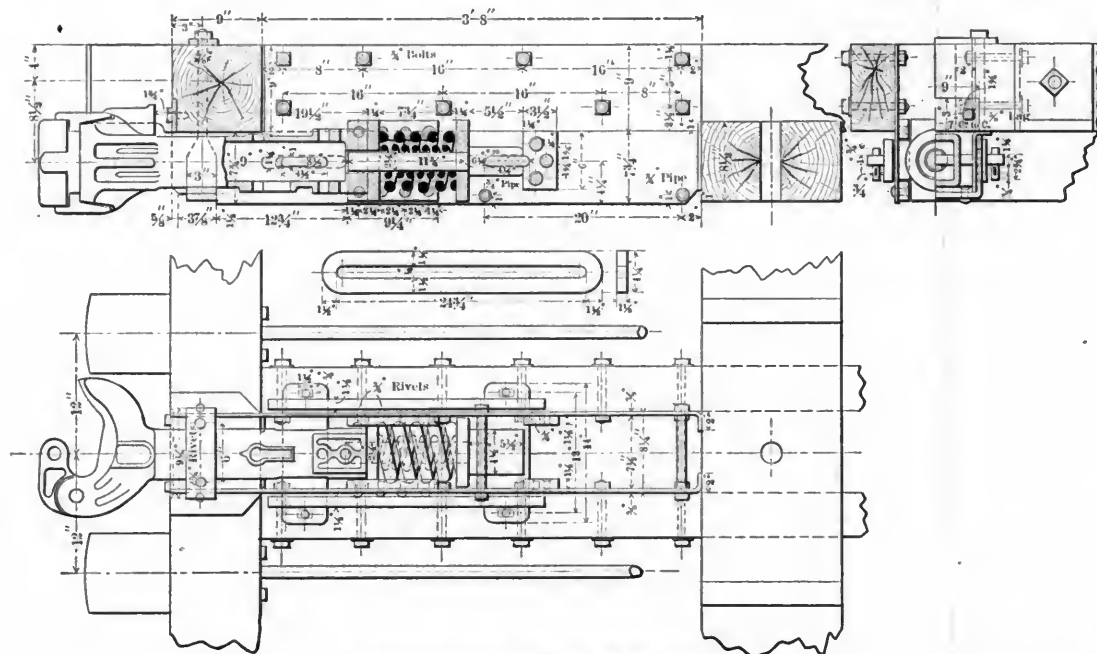
Piece-work withal is very popular with the men, and, as one of the foremen remarked, a proposal to return to the day's work system would probably produce a strike. Wherever, as is sometimes the case, it is necessary to put men at work temporarily, on day's work, it causes grumbling and dissatisfaction. On careful enquiry among, not only the heads of the various departments, but of the foremen of the various shops, it was found that the saving in the cost of work was estimated at from 35 to 65 per cent., and all were agreed that the amount of work turned out was doubled. The possibility of halving the cost of labor and doubling the output of work in a railroad shop is a result which certainly ought to be worthy of investigation by those who control expenditures, especially when the system may be introduced in a partial and experimental way with so little risk.

To illustrate the importance of this, it may be said that the cost of maintenance of equipment on the Pennsylvania Railroad last year was, in round figures, \$9,500,000. About half of this cost, or \$4,750,000, was for labor. To reduce this one-half or even a quarter is an object worth accomplishing. Besides such a saving an increase of business would be sure to demand additional shops, tools and other facilities for doing repairs before long. If the capacity of existing shops and their equipment can be doubled, as it is claimed in Altoona it has been in their shops, the extension may be postponed for a decade or longer. There is only one difficulty in the way of its introduction and successful operation in any railroad shops, that is the need of intelligent, careful, faithful and *righteous* supervision, without which it is doomed to failure. It is because it has had this in Altoona that it has succeeded to the extent it has.

It may be added, in the form of a postscript, that the information with reference to the results attained by the piece-work system in Altoona was not obtained from any one source, but was the result of independent interviews with the heads of different

A New Freight Draft Gear.

It will be seen that the design does away with all vertical bolts through the center fills, and that therefore the entire draft gear can be taken down without entering the car. This is a great advantage when repairs are to be made to loaded cars. The gear appears to be of ample strength. Mr. Tomlinson, in writing to us regarding it, says: "It may be adapted either to cars with one or two draft sills, or may be applied between sills without draft timbers, or to cars with steel or iron body framing. I have only applied it to three cars, for the reason that I wished to test it fully and beyond all question, and for a reasonable time. The test has extended for 13 months, and at the expiration of this time a careful examination shows that no repairs are necessary, and that in detail each part is in as good condition as when applied, so that I am now having the gear carefully gone over and parts redesigned to suit the various types of cars, and it is quite possible that the draft plates will be made of pressed steel, with follower guides formed integral therewith. The ease with which each individual part can be removed and replaced, the large factor of



A Freight Draft Gear with Steel Draft Sills.

The builders' trial trip of the *Iowa* took place last month, and the vessel averaged 16.27 knots in a strong gale during a four hours' run, the engines developing about 11,000 horse-power at 112 revolutions. The contract speed is 16 knots.

The Value of a Steam Jacket on a Locomotive.

The research committee of the Institution of Mechanical Engineers (England) have recently made a report on "The Value of the Steam Jacket," prepared by Prof. T. H. Beare and Mr. Bryan Donkin, in which is given the account of an experiment with jacketing the cylinders of a locomotive. The trials were undertaken and carried out on the Lancashire & Yorkshire Railway, at the suggestion of Mr. John A. F. Aspinall, Chief Mechanical Engineer, who gave every assistance to the experimenters. Owing to the fact that these trials were carried out on a locomotive doing its ordinary train service, it was impossible to obtain results as complete and thorough as would have been aimed at had the experimenters been able to make the trials on a special train, the working of which could have been arranged to meet the necessities of the experiment. The trials were of short duration and the condition of the fires at the start and the finish of each had to be determined by the necessities of the traffic requirements and could not therefore be varied to suit the wishes of the experimenters. The consumption of steam was obtained with a close approach to absolute accuracy; but the same cannot be said respecting the fuel consumption, owing to the above circumstance with regard to the condition of the fires. The results obtained are therefore not such as will enable any definite conclusions to be drawn as to the value of the steam jacket in locomotives. They are, nevertheless, interesting and valuable; and having involved considerable trouble on the part both of the experimenters during the trials and of Mr. Aspinall in the preparation of the engine for the experiment, it has been thought advisable to publish them for the use of the members. We present this condensation of the report to our readers:

"The experiment was made on a passenger locomotive, No. 1093, during its regular work of taking the 7.30 a. m. express train from Manchester to York, a distance of 76½ miles, and returning with the 3.00 p. m. express from York to Manchester. Both engine and tender are the ordinary standard pattern of this railway. The engine is a four-wheeled coupled with bogie truck, the driving wheels being 7 feet 1 inch diameter and the bogie wheels 3 feet 0¼ inch. The cylinders are inside and horizontal, with their valve chests on the top. The engine wheelbase is 21 feet 6½ inches, and the total wheelbase of engine and tender 41 feet 1½ inches. The weight of engine and tender when empty is 56,287 tons, and when in working order 80,925 tons, the tender carrying 1,800 gallons of water. The boiler is of steel, 4 feet 2 inches diameter and 10 feet 7½ inches long; the firebox shell of steel, and the firebox of copper, 6 feet long, 4 feet 1 inch wide, and 5 feet 10 inches high. There are 220 tubes of 1½ inches outside diameter. The heating surface in the tubes is 1,108.73 square feet, and in the firebox 107.68 square feet; total, 1,216.41 square feet. The fire-grate area is 18.75 square feet, the ratio of heating surface to grate area being 65 to 1. The fire-brick arch in the combustion chamber is about 2½ feet long. The height of the chimney above the fire-grate level is 10 feet. The cylinders were originally of the normal pattern, 19 inches diameter and 26 inches stroke. For this experiment they had been bored out and fitted with cast-iron liners, which reduced the internal diameter to 17½ inches, thus providing a body jacket of ½ inch space. The front cylinder covers were fitted with external covers, the space between the two forming a steam jacket. The back covers, however, were imperfectly jacketed by fitting over them, as close to the actual covers as possible, an annular wrought-iron ring with an inner and an outer cover, the space between the latter two forming a jacket space. The external surfaces of the end jackets were much exposed, and not well covered. A table accompanying the report shows the clearance volumes of the cylinders, and the jacketed and unjacketed internal surfaces exposed to steam in the clearances alone, and also in the clearances and cylinders at 90 per cent. of the stroke. It shows that the proportion of the clearance surface jacketed is only about a quarter of the whole, and this is mainly due to the cover jackets; of the back ends, therefore, a large part is hardly jacketed at all, in the true sense of the word.

"Four trials were made, A, B, C, D, on Sept. 18 and 19, 1894; A unjacketed and B jacketed on the 18th; C jacketed and D unjacketed on the 19th. A and C were made on the runs from Manchester to York and B and D on the return runs from York to Manchester. In each trial the weights of coal and feed-water consumed were measured, and readings of the various gases were taken, and the position of the reversing gear was noted. Indicator diagrams were obtained, and in trials C and D samples of the furnace gases were collected from the smokebox below the exhaust pipe. The coal used in the trials was from the Mitchell Main Colliery, Wombwell,

near Barnsley. Samples were taken from each sack used, and were submitted to Mr. Charles J. Wilson for determining the calorific value in a calorimeter. The mean value from his tests were 14,200 thermal units per pound of dry coal, equivalent to an evaporation of 14.7 pounds of water from and at 212 degrees Fahr. The actual coal consumption per indicated horse-power per hour of steaming time in the four journeys was, respectively, 2.87, 3.07, 2.73 and 2.79 pounds.

"On the first day no attempt was made to collect the gases; and as the thermometer for taking their temperature had been fixed above the blast-pipe orifice, it was not thought worth while to note its readings. On the second day the gases were collected continuously; but the thermometer, placed in a better position, unfortunately broke almost immediately after leaving Manchester, so that the temperatures could not be ascertained. The difficult operation of collecting the gases while going at express speed was carried out by Mr. Michael Longridge. During the outward journey C much trouble was experienced, owing to the heavy chimney-blast; but in the return journey D everything worked quite satisfactorily. The mean results of the three analyses made from the sample collected on each journey are the following volumetric percentages: Trial C carbonic acid, 12.85 per cent.; oxygen, 4.15; carbonic oxide, 0.80; nitrogen, 82.20. Trial D, carbonic acid, 15.10; oxygen, 1.97; carbonic oxide, 0.85; nitrogen, 82.08 per cent.

"As arranged by Mr. Aspinall, the feed-water was measured by means of a Siemens water meter on the pipe between the tender and the injector. The overflow from the injector was caught and allowed for.

"The jackets were drained into three small tanks carried upon a temporary staging on the front of the engine; one measurement was made for the two body jackets together; another for the two front covers, and a third for the two back covers. While standing at York on each day radiation tests were made, by measuring the quantity of steam condensed in each pair of jackets with the engine standing, all hot; these lasted 2½ hours on the first day and 1½ hours on the second. The following were the results obtained:

Condensation of Steam in Jackets, Pounds per Hour.

	While running.			While standing.		
	Sept. 1, B.	Sept. 19, C.	Sept. 19, D.	Sept. 18.	Sept. 19.	Sept. 19.
Two body jackets.....	267	211	155	35.0	26.7	13.7
Two front covers.....	123	163	163	16.0	13.7	13.7
Two back covers.....	65	55	55	12.0	12.8	12.8

"Indicator diagrams were taken simultaneously from both ends of each cylinder. The speed in miles per hour was continuously registered by a Boyer speed recorder, kindly lent by Mr. Aspinall.

"The mean results of all the important observations may be stated thus: Comparing trials A and C, both from Manchester to York, the jacketed trial C shows a consumption of 24.49 pounds of steam per indicated horse-power per hour, against 26.70 pounds for the non-jacketed run A, or a saving of 8.3 per cent. by jacketing. Comparing trials B and D, both from York to Manchester, the figures are 24.48 pounds and 24.87 pounds respectively, or a saving of 1.5 per cent. by jacketing. Comparing the figures for coal consumption in trials A and C, the jacketed trial C shows an economy of .14 pounds per horse-power per hour, or practically 5 per cent., the increased consumption per train mile in this run being accounted for by the greater load hauled; the load was 8 per cent. greater in C than in A, the average speed being nearly the same in both runs. Comparing trials B and D, however, the jacketed trial B is distinctly less economical, the coal consumption being .29 pounds greater per horse-power per hour than in the non-jacketed trial, or 10 per cent. more; and the consumption is also greater per train mile. In these two trials, while the weight of train hauled was the same, the speed was nearly three miles an hour greater in the non-jacketed run D, with a correspondingly much increased horse-power."

In spite of the rumors as to the condition of the equipment of the B. & O. Railroad, scarcely six per cent. of the cars and locomotives are in the shops for repairs. This is a wonderfully good showing, considering that the B. & O. has 875 locomotives and 82,000 cars, and traverses a very rough country. Much of the equipment that was in bad order at the beginning of last year has been thoroughly repaired and is again in service. All but 16 of the 75 new engines, which were ordered by the Receivers last spring, have been delivered and are giving eminent satisfaction.

The company is preparing to extend its compressed air plant at the Mt. Clare shops. A new locomotive repair shop is being built, and compressed air will be very extensively used. Two 50-ton cranes have been purchased for this shop, and the power will be electricity furnished by the power-station that also furnishes the electricity for the motors and Baltimore City tunnel.

Tests 1 and 2 represent a good muck-bar axle; tests 3, 4 and 5, a Western scrap axle, and tests 6, 7 and 8, an Eastern scrap axle. Tests 9 to 11 were made both with the steel in its natural state

A comparison of the axles treated by the Coffin process with the steel axles untreated or with the iron axles is very much in favor of the Coffin process. For instance, the loss in weight of the open-hearth steel treated with the Coffin process averaged 10.3 per cent. (see diagram), while specimens from the

Results of Abrasion Tests of Iron, Steel Untreated, and Steel Treated by the Coffin Process.—Cambria Iron Company's Laboratory, 1896.

same axles untreated averaged 12.7 per cent., an increase of 23.3 per cent. expressed in terms of the lower figure. In the same way, if we average the three sets of iron axle tests (Eastern, Western and muck bar scrap), the loss is 21 per cent., or more than double the loss of the treated open-hearth steel.

These figures give a strong testimony to the value of the Coffin process of treating steel axles, crank-pins, etc., which is fully borne out by the results from actual practice. In an article on annealing, by H. K. Landis, which recently appeared in the *Iron Age*, some statements are made on the general subject that incidentally substantiate the claims for the Coffin process, and are of interest in this connection. Mr. Landis says:

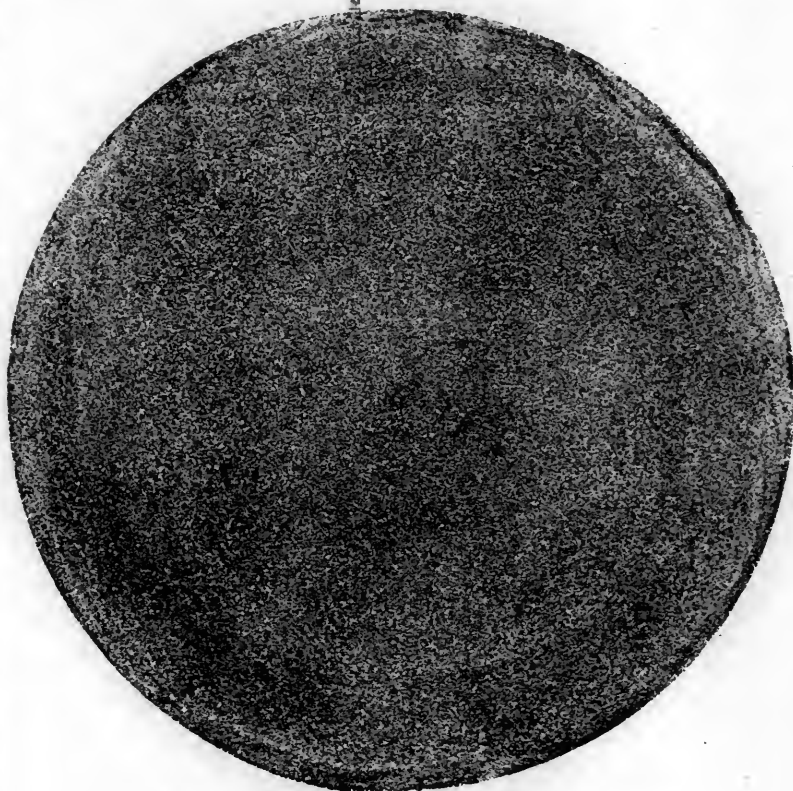
After casting, forging, rolling, or drawing, steel is more or less afflicted by contending tensile and compressive stresses, often local in character but always injurious. The cause of such local strains may be incomprehensible cores in castings, local forging, either hydraulic or by hammer, rolling at too low a temperature, cold wire or tube drawing, etc.; but whether frequent cracks or breaks appear or not, the fact that these do occur occasionally is sufficient evidence that strains incident to the process do exist. It is impossible to tell what strain there is in the interior of a shaft having larger sections forged upon it. . . . Yet we find very few among the host of iron workers in this country who adopt precautions to prevent accident by providing means for removing such strains. The remedy is simple and lies in heating the piece up to temperatures to be determined by subsequent treatment, ranging from 900 to 1,600 degs. F., and allowing them to cool more or less slowly. The high temperature allows the strains to adjust the particles of steel and produces a satisfied condition in the material, the rapidity of cooling afterward determining the final state or condition of the steel. The highest temperature reached determines the extent of the effect, whether

hardening or softening, while rapidity of cooling determines the quality possessed by the piece afterward. . . . If the idea is simply to remove strains in a piece, it may be heated to 1,000 degrees and cooled in the air, upon which it will be found to be tough. If greater toughness is wanted it may be cooled more rapidly, depending upon the quantity of carbon present in the steel."

The special treatment in the Coffin process is well calculated to give all the toughening effect indicated above and also to render the material dense and fine grained. We reproduce herewith the etchings of an iron axle and an open-hearth steel axle treated with the Coffin process. The photographic process is hardly adapted to the reproduction of the steel etching, as the minute, but important, changes which indicate the increasing fineness of structure near the circumference of the section are partly lost. Those of our readers who are sufficiently interested in the matter to write to the company can doubtless obtain impressions taken directly from the etched section.

Japanese Cruisers Contracted for in the United States.

During the past month the Japanese government placed contracts in this country for two armored cruisers, the Cramps of Philadelphia and the Union Iron Works of San Francisco each getting one to build. Each cruiser will be of about 5,700 tons displacement and will have a speed of 21 knots. The length on the water line will be about 330 feet; beam, 51 feet; draft, 20 feet; and the engines will develop 17,000 horse-power. The battery will consist of four 8-inch guns, eight 5-inch rapid-fire guns, twelve 6-pounders, four 1-pounders, and four Gatling guns. The boats must be completed in two years. The price is about \$1,250,000 each. Large contracts have also been placed in Europe by the Japanese government.



Etching of Open-Hearth Steel Axle Treated by the Coffin Process.



Section of Wrought-Iron Axle.



Locomotive for a Six Per Cent. Grade.—Pittsburgh, Cincinnati, Chicago & St. Louis Railway.

A Locomotive Operating on a Six Per Cent. Grade—Pittsburgh, Cincinnati, Chicago & St. Louis Railway.

The engine, which we here illustrate, was especially designed for use on Madison Hill, Ind., on the Louisville Division of the Southwest system of the Pennsylvania lines. For the photograph and description of it we are indebted to Mr. S. P. Bush, Superintendent of Motive Power, who was called upon to provide for the unusual conditions existing at that point. The peculiar conditions of the service at that place necessitated many departures from customary locomotive construction, and the proportions of the engine are consequently somewhat different from ordinary practice, and, in cylinder volume, it does not entirely conform to the rules recommended by the Master Mechanics' Association.

The grade upon which this engine has to wear away its existence, climbing and pushing with all the power its weight permits of, and then gliding down again without steam, is one of the steepest in the world upon which a regular passenger and freight service is maintained with the sole aid of adhesive power. The length of the grade is 7,012 feet and the total elevation is 413 feet, making a ratio of 311 feet per mile, or approximately a 5.9 per cent. rise.

When ascending this grade the cars, as a precaution in case of broken couplings, are pushed before the engine, and when descending the engine backs down preceding the cars. It is to be understood that the regular road engines are disconnected from their trains at the top of the grade, and left there waiting for the next train brought up by the hill engine.

In order to prevent the trains from gaining too much headway during the descent the engine is equipped with an interesting arrangement for regulating the speed. This device is based on the principle of the Chateller brake, and is in some respects similar to that used on several of the Western mountain roads. It consists of connecting the valve chests with a $\frac{1}{4}$ -inch pipe from which a 2-inch connection runs back to a point below the cab floor at the engineer's side where it terminates in a muffler. When descending the hill the link motion of the engine is reversed so that the cylinders during a portion of the stroke will force air up into the valve chests and from there through this pipe to the muffler, where it escapes into the atmosphere. By means of a regulating valve below the cab floor the escape of the air can be checked so as to obtain the desirable speed for the pistons and consequently for the engine. By closing the valve entirely the engine can be stopped during the descent.

In order to prevent the pistons sucking in air from the smoke-

box with accompanying cinders and grit, a steam jet is directed upward through the exhaust pipe from an opening in the hollow wall dividing the two exhaust passages. Fresh, clean air is admitted into the cylinders from a connection at the exhaust pipe base which leads to the outside of the smoke-box, and is shown over the valve chest in the illustration. This connection can be opened or closed by means of a valve operated from the cab, and it is apparent that it must be opened only when descending the grade. In order to lubricate the cylinders a small jet of hot water is let into each exhaust passage.

Besides this regulating device the engine is equipped with the American driver brake, and in addition a powerful screw hand brake, which alone will hold the engine and train on the grade.

As before stated, the service for which the engine was designed necessitated a departure from the customary proportions of locomotives. A road engine has to exercise its entire hauling capacity only when starting a train and getting up speed, but during the majority of the time only a fraction of the tractive power is needed. The total adhesive weight on the drivers is never utilized when the train is running at its regular speed with the lever hooked up toward the middle. It is then that the economy of expansion comes in. The exertion of the full adhesive power is not the exception but the normal condition of work on the Madison Hill. To use steam expansively under these conditions would be impossible, unless the cylinders were of much greater proportions, with regard to the adhesive weight, than on the ordinary road engine. The total weight of the new engine is 140,000 pounds, all adhesive weight, but the mean weight during the ascent is about 130,000 pounds, based on consuming two-thirds of the water in the side tanks. According to ordinary practice this weight would require a cylinder of about 22 inches by 24 $\frac{1}{2}$ inches. The additional $3\frac{1}{2}$ inches of the stroke which this engine has is a clear gain in the expansion of the steam, over and above that which may be produced when the engine does not exert its full adhesive power up to the slipping point. In other words, the cylinders were made as large as it was practical to make them, and the economy of this is shown by the fact that ordinarily the engine is able to make three round trips up and down the hill without refilling its coal bunker, which holds only a ton and a half of coal.

The engine was placed in service the first of the year, and has been giving entire satisfaction ever since. No official test of its hauling capacity has yet been made, although it is the intention to do so in the near future in order to obtain reliable data for

comparison and future use. It can be said now, however, that the engine has fully met the expectations of the officials, and its performance during the ascent, as well as the descent, is entirely satisfactory.

Quite a number of interesting details had to be considered in the design of the engine. In order to keep the front end of the top row of flues under water on the grade without filling the boiler so full as to cause the engine to throw water the back end of the boiler is set considerably higher than the front end. The throttle valve is of the ordinary balance type, but it has no play on its stem, the object being to avoid the clattering of the valve upon its seat in case the compression in the steam chest should exceed the boiler pressure during the descent. To protect the steam chests a relief valve has been placed on each, which is set just beyond boiler pressure. In arranging the driving springs for the engine it was calculated that the front springs would receive the greatest load and they were designed accordingly. When the engine is on the grade, however, its center of gravity is shifted backwards, and in consequence the rear springs receive the greatest load, which caused some little inconvenience at first.

Instead of metallic piston-rod packing, asbestos cord is used, as the metallic packing would be apt to be damaged when the engine is drifting down the hill without steam. The engine is equipped with a pneumatic bell ringer, pneumatic sand valves, steam heat for passenger trains, and all modern improvements.

The leading dimensions are as follows:

NO. 634—TANK LOCOMOTIVE, NON-COMPOUND, STANDARD GAGE.

Fuel.....	Bituminous coal
Driving wheels, number.....	8
" " diameter.....	50 inches
Driving axle journals by 3/4 inches.....	5 1/2 inches
Wheel base (all rigid).....	15 feet 3 inches
Cylinders, diameter.....	22 inches
" " stroke.....	28 inches
" " spread of centers.....	7 feet 4 inches
Crosshead.....	Solid cast steel
Main rod, length between centers.....	9 feet 10 1/2 inches
Valve gear.....	Stephenson link motion, Richardson balance valve
" " steam ports.....	1 1/4 inches by 18 inches
" " exhaust ports.....	2 3/4 inches by 18 inches
" " outside lap.....	1 inch
" " inside lap.....	3 inch
" " valve travel.....	60 inches
" " lead.....	1/8 inch
Boiler: Inside diameter of barrel.....	5 feet
" " Thickness of sheet.....	7/16 inches
" " Height from rail to center.....	27 square feet
" " Steam pressure.....	150 pounds
Firebox.....	Belpaire
" " Length inside.....	7 feet 9 1/2 inches
" " Width " at bottom.....	3 feet 6 inches
" " Depth.....	4 feet 9 1/2 inches
" " Grate area.....	27 square feet
Tubes: Number.....	219
" " Diameter outside.....	2 inches
" " Length between tube sheets.....	13 feet 4 1/2 inches
" " Total area of tube sections.....	3.55 square feet
Heating surface, firebox.....	112.86 square feet
" " tubes, exterior.....	1,528.89 square feet
" " total.....	1,671.75 square feet
" " ratio to grate area.....	61.91 to 1
Exhaust nozzle, single, diameter.....	5 inches
Smoke stack, minimum diameter.....	18 inches
" " height from rail.....	15 feet
Capacity of tanks.....	2,000 gallons
Capacity of coal space.....	3,000 pounds
Tractive power, per pound, effective pressure on piston.....	271 pounds
" " total with 80 per cent. of boiler pressure.....	32,580 pounds
" " total adhesive, at 25 p. c. weight on drivers.....	35,000 pounds
Weight in working order.....	110,000 pounds

More Engineer Officers Required in the Navy.

The necessity of increasing the number of engineer officers in the navy is touched upon in the annual report of Commodore Melville, Engineer-in-Chief of the Bureau of Steam Engineering. He warns Congress, and incidentally the country at large, of the futility of building powerful warships without providing the necessary number of skilled officers to operate and maintain them. He says:

"I feel that it is only necessary to direct your attention to the number of engineer officers who have been retired during the past year for physical incapacity, and to the steadily increasing number of such officers on the retired list, to demonstrate that the physical strain to which the officers of the engineer corps are subjected is too great. In former annual reports I have given what I believe to be abundant reasons for an increase in the number of officers of the corps. As time goes on, and the number of ships and their power increase, the necessity for such an increase is intensified, and I feel that I would not be doing my duty if I did not again briefly refer to the matter.

"The personal element is one which must enter largely into the result of any naval engagement, and if we had the most powerful and the swiftest navy afloat it would be valueless to us in time of war if we had not a sufficient number of trained men to see that the machinery of this fleet is in condition for action and to keep it going in action. The guns will be powerless without the machinery, and, other things being equal, that fleet will give the best account of itself which has the best equipment of trained men in the engine-room, as well as at the guns. To sacrifice the one is merely inviting disaster to the whole, and no amount of skill on deck can compensate for the lack of it below."

It is to be hoped that Congress will take steps to correct this present weakness of the navy at its next session. The personal element is not made unduly prominent in the above statement, as any one who reads the past history of our own navy will readily appreciate. If the policy of this country is going to be the maintenance of a navy of only moderate size it is all the more important that every element tending to make it superbly efficient should receive attention. The most important naval matter now calling for consideration is the status of the engineer officers and the much-needed increase in their numbers.

The June Conventions for 1897.

The Master Car Builders' and Master Mechanics' associations will hold their annual conventions in 1897 at Old Point Comfort. The Hotel Chamberlin has been selected as headquarters, and the hotel rates will be the same as usual, namely:

	Without bath.	With bath.
Single room, 1 person.....	\$3 per day	\$4 per day
Double room, 1 person.....	4 "	5 "
Double room, 2 persons.....	4 "	5 "

The Hygeia Hotel, across the street from the Chamberlin, will make the same rates to members and their friends. At the Chamberlin rooms will be assigned only to members of the associations until March 1, after which application from others will be received. The Chamberlin is a new hotel of large dimensions and with excellent accommodations, and with the two hotels open there should be ample room for the great numbers who now attend these conventions annually.

The Baltimore & Ohio Tunnel Plant.

Within the next six weeks the three General Electric motors that have been used for the past year in hauling freight trains through the Baltimore City tunnel of the Baltimore & Ohio Railroad, will begin to handle the passenger trains in the same manner. The overhead trolley is being extended three-quarters of a mile north of the Mt. Royal station and about 1,500 feet at the south end of the tunnel. The motors are giving splendid satisfaction. The maximum load that has been hauled so far consisted of 41 loaded freight cars and two heavy locomotives. By the extension of the trolley line north and south of the tunnel entrances the helping engine will no longer be needed.

The new Mt. Royal station, at the northern end of the tunnel, is almost completed and it is a handsome and well-appointed passenger station. Attention has not only been paid to the architectural beauty, but the landscape gardener has given his best efforts toward beautifying the surrounding grounds. It is probable that the company will reconstruct its Camden station, at the other end of the tunnel, so that passenger trains will not have to back in and out, as has to be done at present. It is contemplated to erect new passenger sheds and necessary buildings near the mouth of the tunnel, by which the movements of trains between Washington and New York will be greatly accelerated.

The electric power plant is now being used not only to furnish the power for the tunnel motors, but to run 180 street cars of the Baltimore Traction Company, to light the Camden station and yards, the Baltimore City tunnel, the Locust Point freight-houses, warehouses and yards, Mt. Clare shops and the new Mt. Royal passenger station.

The four large engines generating electricity for power purposes are to be supplemented by a fifth engine. The foundations for it were laid long ago, and the installation of the engine is now

in progress. A 250 horse-power engine is also being added to the equipment devoted to lighting purposes.

A use for compressed air new to most of our readers is found in this plant. This is its utilization for forcing oil to the cups that lubricate the machinery. Tanks of oil are kept under about 60 pounds' pressure, and from these the oil is piped to the various bearings of the engines and dynamos. At the cups the pressure is about six pounds. The cups are always full of oil, and the rate of flow is adjusted in the usual way. The cylinder lubricators are not included in this compressed-air system, but cylinder oil is delivered under air pressure to a convenient faucet in the engine-room, where it is drawn off into cans for filling the lubricators. Westinghouse pumps maintain the air pressure.

The system installed by the movement of trains through the tunnel is, of course, very irregular at present, giving long intervals when no power is used. To meet this condition a low, smouldering fire is maintained under the boilers, and the machinery is kept at a standstill except when trains are being moved. The approach of each train is telegraphed to the power house, when the blowers are speeded up and steam is soon generated at a rapid rate and the engines and dynamos are started up to supply current for the moving of the train by the electric locomotive.

Electric Traction Under Steam-Railway Conditions.*

BY DR. CHARLES E. EMERY.

In the light of recent achievements, it can be assumed at the outset that electric traction under steam-railway conditions is feasible. The only question is whether it will pay. The present applications only prove the former proposition, but do not touch the latter.

The greatest practical efficiency of an electric system of the kind proposed between the engines at the central station and the rails would probably be 60 per cent. This, on account of a second transmission to sub-stations and the necessity of using rheostatic regulation to some extent, would probably be reduced to 50 per cent., so that twice as many horse-power would need to be generated at the central station as at the track with the present steam locomotives. Each horse-power in the central station will be developed for two pounds of cheap coal or four pounds per net horse-power delivered, whereas the steam passenger locomotive will on the average require six pounds, based on net tractive force and allowing for the various wastes. The saving in coal due to electric passenger traction will, therefore, be one-third. Coal is procured cheaply by the railroads, but probably an inferior quality, costing 50 cents per ton, or, say, 25 per cent. less than that used on locomotives, could be employed in the electric stations, so that, for trains of like weight the saving in cost of coal for passenger service would be $\frac{1}{3} \times \frac{3}{4} = \frac{1}{4}$. For freight engines we calculate the saving in cost for fuel will be about 55 per cent., and for switching engines about 60 per cent. On railroads running through the coal regions the total cost is about 9 per cent. of the total operating expenses. A saving of one-half in the cost of the coal, then, corresponds to a saving of 5 per cent. of operating expenses. For reasons that will be stated later, it is believed that, for general railroad work, independent electric locomotives will be required, and that these will necessarily be as heavy as present steam locomotives, on which basis the only saving in weight will be that of the tender, which we have assumed as 10 per cent. of the total weight of the train for passenger engines, 3.3 per cent. for freight engines, and 5 per cent. for switching engines. The total load to be hauled will therefore be decreased by these several percentages, and the cost of coal reduced thereby to 45 per cent. of that required by the present locomotives for passenger trains; 43½ per cent. for freight trains and 32 per cent. for switching trains. Applying these percentages for the relative amounts of coal used for these different purposes on a prominent railroad, the average saving in fuel becomes 58.9 per cent., or 5.89 per cent. of operating expenses. The cost of water is taken at two-thirds of 1 per cent. on the same basis which increases the saving to 6.56 per cent.

Considerable saving has been claimed on other grounds. First, in relative repairs of electric motors compared with locomotives. Repairs will be less on the motors, of course, but they are not inconceivable, and when we consider that the transmission line, trolley line and trolleys must be kept in repair as well as the motors, it

cannot be far in error to assume that the question of repairs will be about balanced, independent of central station apparatus otherwise provided for.

It has been claimed that labor will be saved, because the second man on an electric locomotive is required simply to provide for sickness or accident of the driver, and can well be the baggageman of a passenger train or the conductor of a freight train. Something of this kind may be worked out on an unimportant country road, but it would be impracticable on a large business scale.

It is also claimed that there will be a saving in the weight and cost of electric locomotives, particularly when applied under a car, but this system is of limited application. Heavy locomotives on trunk lines must have the same weight for electric as for steam traction, independent of the tender. Large savings in repairs to tracks and bridges are also claimed on account of the smoothness with which electric locomotives, having no reciprocating parts, would operate. The same weights must be run over the same rails at the same speed, and at least a great part of the wear and tear would be due to inequalities of the track surface, which would influence both systems alike. The present locomotives are so designed that, while the wheel loads on the drivers are heavy, the masses which strike blows are comparatively light; that is, they have simple wheels and axles, spring-connected to the frames. This is a very difficult thing to accomplish with an electric locomotive without using exactly the same construction. Each pair of wheels and attached motor acts as an enormous trip-hammer on the rails and roadbed the moment the former gets the least out of alignment. A connection to driving axles through gearing reduces the blows very materially, but introduces at high speed another difficulty. The vertical movements of the main axle would necessarily cause a change in the angular velocity of the armature during the time of such movement, which, for jars occurring in the fraction of a second would bring a heavy strain on the gearing and vary the speed of the armature momentarily. The variations in current due to such variation may also give a longitudinal pulsation to the train. The matter is not helped at all by mounting the motors on hollow axles concentric with the driving axles, so that the motors may be spring-supported from the axles, for in such case the connection of the motor to the axles must be through links the equivalent of a universal joint, which produce variations in velocity, when the axles are out of center with the armature, similar to those where gearing is employed.

For reasons above given, it will be necessary to mount electric motors for fast locomotives away from the centers of the axles and connect through side rods, as in the present locomotives. There is another important reason for this. In order to obtain speed, the motors must be wound for it so that the counter-electro-motive force will be produced by velocity rather than the number of turns, and, in starting, the motors are necessarily connected in series so as to reduce the starting current. For motors adapted to very high speeds, it will be necessary to put pairs in series even to surmount heavy grades, to act as pushers in case of accident, or in removing snow, etc. The counter-electro-motive-force is therefore divided between several motors, but not necessarily in equal degree. If, with motors connected to separate axles, one for any reason slips its wheels, it will monopolize the larger portion of the electro-motive force and cut down the current on all the motors in series, so that full power cannot be obtained. Working the motors in parallel with an enormous rheostat would be wasteful, and, in some cases, impracticable. It is, therefore, important for two reasons to connect driving wheels operated by separate motors by means of side rods.

Again, it is essential, that, on the road, speed be regulated by better means than a rheostat. A series motor varies its speed with the load and so cannot run without rheostatic regulation at a given speed if for any reason the number of cars in the train or the track resistance varies. It will, therefore, be necessary to return to commuted series field coils or equivalents, and it will be perhaps desirable to have a shunt winding which can be used to give still closer regulation. In fact, shunt motors are being introduced abroad for traction purposes. The use of these devices will increase the weight of the motors compared with simple series-wound motors. These considerations make more room desirable for the motors than can be provided in the trucks of an ordinary car.

For these several reasons it is predicted that the high-speed electric locomotive of the future will, like the steam locomotive, be a structure independent of the train, that the motors will be hung on the frame independent of the driving wheels, and the same as

* From a paper presented at the meeting of the American Institute of Electrical Engineers, New York, Oct. 21, and Chicago, Oct. 28, 1896.

well as the driving wheels connected by side rods. To obtain proper room under such conditions larger driving wheels will be employed than the wheels of an ordinary car. This will so extend the wheel base that it will not be safe to run at high speeds without the leading truck, the same as on an ordinary locomotive, and, in fact, the electric locomotive will in all its general features be a steam locomotive without the boiler, with motors substituted for the steam cylinders. In this way and probably in no other can the flexibility of the present steam locomotive be obtained. Again, it is desirable that the whole locomotive be a unit, on a strong frame, calculated to resist the shocks due to collisions and accidents, and it is doubtful if locomotive drivers will be found who will be willing to risk their lives on any other kind of a structure.

To realize the flexibility of the ordinary locomotive one has but to go on the line of one of the roads which has not yet adopted the heaviest type of rail, but yet runs express trains at 45 miles per hour, grasp a convenient post close to the line and a little around a curve, if possible, where one can take the wind of the train, and watch its approach. In many cases the locomotive sways nearly a foot from the perpendicular, first one way and then the other. At a bad joint the plunge is so rapid that the effect can be described as terrific, as one cannot but think of the consequences if such a mass should leave the rails. The locomotive, however, follows the inequalities as readily as would a farm wagon. Electrical engineers may insist upon a more rigid and better track, but this will require additional expense and will not entirely overcome the difficulty. The electric locomotive must be constructed so that it will do the work of the present locomotive in the same way, and the feature of flexibility cannot be sacrificed.

A modern heavy locomotive costs about \$10,000, which is at the rate of \$10 to \$12 per horse-power, on about the same basis as electric motors would be rated. It needs little argument to show that an electric locomotive, to take its place under conditions stated, would cost fully as much. Moreover, if like care is to be taken of electric locomotives as of those for steam, the same number must be employed of like capacity for like work.

An approximate calculation of the cost of electrically equipping and operating a trunk line has been based on information in regard to the operating expenses of different railroads, given in the series of articles by Mr. Baxter, in *The Electrical Engineer* early this year. We have adopted his facts, and for convenience have used some of his methods, but have been obliged to entirely disagree with his conclusions. For instance, we calculate that the cost of the steam and electric generating plants will be about three times as much as he states, the transmission plant and sub-stations about twice as much, and the operating expenses about $5\frac{1}{2}$ times as much as he provides for. Necessarily the conclusions are diametrically opposite.

The calculations are based on the operating expenses of a railway system comprising nearly 2,700 miles of road, and employing 1,800 locomotives. By calculations based on the train miles, checked by the reported coal burned, and the probable number of engines in use, we estimate it will require 290,000 horse-power in the stations, on the basis of 50 per cent. efficiency from stationary engine pistons to track, and if 60 per cent. can be obtained by commutated fields, or other means herein discussed, the difference simply provides for an expected increase of travel. From the probable average power and the actual reported operating expenses corresponding thereto, we proceed as follows: For facility of calculation and to obtain an underestimate, rather than one too large, the power required for the switching engines is distributed among the regular trains on the road. It is also assumed that the average number of trains is continued the entire length of the road, instead of using a much greater number than the average for suburban travel. These methods cause an underestimate of the cost of the electric transmission, but enable the cost of operation to be accurately worked up from the averages. The latter is the more important point, as the other merely involves comparatively small questions of difference in the amount of interest.

By this generalization the trains will be assumed as separated about $7\frac{1}{2}$ miles, independent of direction, over the whole length of the road for every hour in the year. On this basis there will be required on the average 106 station horse-power per mile of road, independent of direction of trains, but to provide for concentrations which will inevitably occur, the generating plants and transmission lines have been worked out on the basis of 150 horse-power per mile. The assumed number of trains will require on the average about 400 horse-power each at track, or 800 at station. To obtain the economy due to fairly large stations they are assumed to be separated 45 miles from each other, and at two intermediate points transform-

ers and rotary converters (transformers) located, by which means the feeders are supplied every 15 miles. On the above basis it is assumed that 6,750 horse-power is installed at each steam station, and 2,250 horse-power at each sub-station.

To avoid overestimates the cost per horse-power of steam and electric plant in main stations has been assumed as only \$80 per horse-power with \$20,000 for buildings, and for the whole apparatus in the sub-stations there has been allowed only \$10 per horse-power and \$10,200 for buildings and the copper in the high-tension lines. The low-tension copper has been worked out on the basis that half-way between the main and sub-station two trains may meet, each requiring 1,000 horse power, and that a uniform section of copper sufficient to carry $7\frac{1}{2}$ miles, the current required for half of this power, at an original tension of 700 volts and a drop of 20 per cent., would be ample for the whole length of the low-tension lines. On this basis the cost of copper at this basis the cost for copper at 13 cents per pound for the outgoing low-tension conductors will be \$12,386 per mile. It is assumed that provision for supporting the outgoing conductors and the bonds in main track for return current will cost \$5,000 per mile.

On the basis of these prices, without considering incidentals, the total cost of the electrical generating and transmission plant foots up \$31,057 per mile, the annual interest on which, at 5 per cent., is \$1,553 per mile. If the services of the 1,800 steam locomotives can be furnished by 1,500 new electric locomotives at \$10,000 each, the same will cost \$5,556 per mile, requiring \$278 annual interest per mile, making the total interest on steam and electrical plants, including locomotives, \$1,831 per mile. The operating expenses of the station, considered as a steam station only, from Emery's tables, reduced to 24 hours and 365 days, modifying cost of plant and eliminating coal and interest, is found to be \$25.84 per average horse-power per year. The time of 12 extra men for care of electric apparatus in the main and two sub-stations amounts to \$2.75 per horse-power per year, which makes the total operating expenses of the generating, transmission and locomotive plants, exclusive of coal and interest, \$28.59 per average main station horse-power per year, or \$3,031 per mile, or, with interest added, viz., \$1,831, as above, a total of \$4,862 per mile. The operating expenses of the station thus calculated include an allowance for repairs, insurance, taxes and renewals.

It should be recollected that the cost of coal has been already provided for in the percentage of saving first developed, and that the train expenses are assumed to be the same as for steam locomotives. The operating expenses of the road using steam amounted to \$15,187 per mile. Of this, as previously stated, 6.56 per cent. will be saved by the use of electricity, corresponding to \$996 per mile. This subtracted from \$4,862 per mile (given as the cost of operating expenses of the generating stations, etc., with interest added), leaves \$3,866 per mile per year as the additional expense which will be entailed by the application of electricity as a substitute for steam; so, on the basis that the operating expenses are 50 per cent. of the gross receipts, such gross receipts must be increased 12½ per cent. by the introduction of electricity over the whole length of the line, in order to enable the road to pay the same dividends as before.

It may be considered that the results will be changed materially by the use of high-tension transmission throughout. If tri-phase currents at a tension of 10,000 volts were received by each electrical locomotive, the tension reduced by transformers carried by the locomotive, and current employed to operate induction motors directly, or to operate direct current motors through rotary converters also carried by the locomotives, the saving independent of extra transformers and converters would amount to \$9,714 per mile, corresponding to \$466 interest per mile, and reduce the total increased operating expenses to \$3,390 per mile, which would require that the gross receipts be increased 10.2 per cent. in order to pay the same dividend as before, instead of 12½ per cent., for combined high and low tension transmission. The saving in dollars is quite large, but the total costs are so enormous that the saving makes but a small difference in percentage. It will similarly be seen that differences in kind of apparatus employed will have very little difference on the general results, though the savings are important in themselves.

It must be recollected that these results are based on providing electric traction for the whole length of a trunk line. It can hardly be expected that the gross receipts for the whole line will be increased, say one-eighth, by such an application. If, however, the application be made within the radius of suburban traffic such an increase is not only probable, but it may be expected that the cost of operation per passenger mile will be reduced in greater proportion than stated, so that the application of electric traction will pay

from the outset. These considerations will apply to longer distances on railroads like the New York, New Haven & Hartford, where the passenger business furnishes the larger proportion of the income.

Again, it is possible to accomplish with the electric locomotive results that are impossible with the steam locomotive. The power for the former being generated originally in stationary boilers, or in some localities derived from waterfalls, is not limited, and the power of the motor can be increased indefinitely, so that in particular locations a demand either for greater power to obtain more speed, or a greater or more continued tractive force than is now possible with a steam locomotive, can be met by electricity without difficulty.

On the whole, therefore, although the application to the whole length of trunk lines does not seem practicable under present conditions, there is no doubt but that the industry will grow in the future as certainly as in the past.

Communications.

Water-Spray Firing.

EDITOR AMERICAN ENGINEER, CAR BUILDER AND RAILROAD JOURNAL:

I notice that the discussion of Professor Goss' experiments has, among other new (?) things, brought out the fact that a small amount of water introduced into the flame of coal fire in a spray improves the fire, i. e., increases its heat. The daily practice of every country blacksmith for the last 100 years has proved it. The experience of every active member of any fire department is to the effect that the first few streams thrown on a blaze acts almost like so much powder, especially if in a frame building or a pile of lumber.

R. ANGST,

Chief Engineer, Duluth & Iron Range Railroad.

[The point which was especially brought out in the discussion referred to was not that the admixture of a small amount of moisture with a fire was new, but that it was beneficial in a steam boiler, a fact which is certainly not well established or generally known. If our correspondent knows of the actual use of water-spray in firing a boiler of any kind, it would be very interesting to know the particulars.—EDITOR AMERICAN ENGINEER.]

Fire-Resisting Qualities of Graphite Paint.

EDITOR AMERICAN ENGINEER, CAR BUILDER AND RAILROAD JOURNAL:

In your issue of November we note an article on "Graphite Paint for Metal Work." There are so many good qualities about graphite paint, when properly made, that we think it extremely unwise to exaggerate such qualities. In the face of the testimony which you mention, there would seem to be no contradiction possible to the statement that "a fire in the neighboring flour sheds played upon ironwork, painted with graphite paint, for two and a half hours without blistering the paint," and yet we cannot help but think that there is a mistake somewhere in this statement.

Over 25 years ago, the Joseph Dixon Crucible Company, Jersey City, N. J., had its attention called to the virtues of graphite paint, by its mine superintendent, who had for the past 10 to 15 years been making graphite paint and using it on roofs of various kinds in the neighborhood of Ticonderoga, N. Y. It was shown conclusively that roofs properly painted did not require repainting in 10 to 15 years. Furthermore, that as graphite was about three times the bulk of lead, and about twice the bulk of mineral paints, it had correspondingly that much more covering power, and that for economy, as well as for durability, it seemed to be the proper paint to use for protecting roofs, whether of metal, wood or canvas. Believing that graphite paint would be a fitting addition to the company's graphite products, the Dixon Company began the manufacture of graphite paint, uniting with it a certain proportion of silica, and putting it on the market under the title of silica-graphite paint.

During the years since the company began the manufacture of this paint, tests of almost every conceivable character have been made with the paint, but we must confess that we have never yet made a paint that would successfully stand the fire test mentioned above.

There is no question of the fire-proof qualities of graphite, but there must necessarily be some binder to hold the graphite to the painted surfaces. Various oils have been tried, and various other vehicles, and although we have called in the services of many chemists, and even the expert of the National Oil Company, we have yet to find any organic substance in the way of oil or a vehicle that will successfully withstand high degrees of heat, and as we have above said, there are so many good qualities in a graphite paint properly made, that we regret to see any statements made that seem to be exaggerated and which, if tested by an interested party, may cause more or less prejudice against a paint that is destined to be hereafter recognized as a best preservative and protective paint for all kinds of work, exposed to the various agencies so destructive to paint.

Permit us also to say that, during the past two to three years, various graphite paints have made their appearance on the market that lack the essential qualities of perfect graphite paint. There are graphite paints that are made of ordinary plumbago foundry facings; there are even graphite paints that are made of simply mineral paint, colored with lamp black. To such an extent are these paints now made, that it will be well for the public to know just what the article is before orders are placed.

JOS. DIXON CRUCIBLE COMPANY.

NEW JERSEY, Nov. 23, 1896.

The Needs of Our Navy.

EDITOR AMERICAN ENGINEER, CAR BUILDER AND RAILROAD JOURNAL:

Since the launching of the *Indiana*, the first of our 10,300-ton first-class battleships, in February, 1893 (this ship was commissioned during the last of November, 1895), the British Admiralty has designed, constructed, tried and placed in commission the two first battleships of the *Majestic* class, of 14,900 tons displacement. And not only this, but the 12-inch guns forming their main battery are of entirely new design and exceedingly powerful; in fact, they are more than equal to the 13-inch U. S. Naval guns in power, and weigh 16 tons less. The 6-inch and 3-inch (12-pounder) quick-firers, also, and the mounts for all the guns on board are of new design, and all the guns from the largest to the smallest, use smokeless powder, a satisfactory variety of which, called "cordite," from its form, having been secured long ago.

By the time that our two new battleships of the *Kearsarge* class are completed, even though it takes only three years, the British Navy will have been reinforced by all the ships of the *Majestic* class; one or two type ships of a new class of battleship will have been pushed forward to completion and more will be under construction, and three or four dozen cruisers, many of them of high speed and power, fully armed, will have been added to their gigantic navy.

France has under construction some thirty-four ships, and Russia is not so very far behind France, for, taking into consideration the new battleships just commenced, she has almost double the number of armored ships building. Italy, in spite of her poverty, has eight armor-clads building and they are being completed more rapidly than any of her previously constructed ships, and Germany has four and Spain five armored ships building.

During the time that the new United States ships are under construction it would seem probable that Great Britain can safely be counted on to complete 12 ships of the battleship class, France five or six and a couple of armored cruisers, and Russia twice as many battleships and armored cruisers as France, as she has a large number of armor-clads completing afloat, besides those on the stocks.

Following the example set by Great Britain in working nights by the use of the electric light, in completing the *Magnificent*, she is pushing the completion of some of her ships by night as well as by day, and it is hoped that the new ships recently laid down will be completed in two years by following this system.

Naval construction seems to be the fad of the age as far as nations are concerned, and the Argentine Republic, with its 4,000,000 inhabitants, has to-day laid up at its naval station on the Tigre River more first-class torpedo boats than the United States will possess when all those building and authorized are completed, and she is having built in Great Britain six "destroyers" of the same type as the Russian *Sokol*, an improvement on the British *Havock* class of boats, both of which you have described.

When Ex-Secretary Tracey, some years ago, told us what position the United States Navy would occupy among the navies of the world, when all the ships authorized were completed, it is evident

that he did not take into consideration the increase that would take place in all the other great navies, and the increased rapidity of construction the world over. Nothing is plainer to a person who reviews the present condition of the United States Navy, and compares it with the other navies, than that it is entirely inadequate to the present needs of the country.

If we are ever to have a navy at all in keeping with our probable needs, and are not going to try and construct one in an emergency, at great cost, and then probably make a failure of it, it is surely time that we set about its construction in sober earnest, following some well-devised plan formed with a definite object in view.

And now, what of all our experiments with wire-wound guns, of which we heard so much at one time? The new Woolwich (British government) 12-inch guns are wire-wound and steel-jacketed. The new Elswick (Armstrong) 12-inch, 8-inch and 6-inch guns are wire-wound and steel-jacketed. British, Japanese, Italian, Argentine and Chilean ships are being armed with these guns.

The new Woolwich 12-inch guns give a muzzle energy of 33,940 foot-tons, and a perforation of 38.5 inches in wrought iron. Our 13-inch guns, with their 16 tons more weight, have 33,627 foot-tons of muzzle energy, and perforate 34.6 inches. The Elswick 12-inch guns for Japan are even more powerful, as they are five calibers longer. Both these guns, it is said, can easily be loaded and fired twice while our 13-inch guns are being loaded and fired once. Some comparison might be made between our 8-inch and 6-inch guns and those of Woolwich and Elswick, and with the same general result.

Now, right here is an illustration of what smokeless powder will do, for a good smokeless powder will make the 40 caliber U. S. guns practically the equals of the 40-caliber Elswick guns just mentioned, as far as perforating power is concerned, but it won't alter the breech action of the United States guns making them into quick-firers capable of firing five shots in two minutes, instead of two shots in three minutes. The Elswick people claim four shots a minute for their new 8-inch gun with the light (210 pound) projectiles!

For some time past we have been turning out new ships with 4-inch and 5-inch guns of the quick-firing type, not using smokeless-powder charges (a grave defect), but with their 6-inch and larger guns of the ordinary pattern of breech-loaders; while Great Britain, France and Italy, to say nothing of the smaller powers who purchase guns of Armstrong, Krupp and Calet, have been re-arming their older ships with quick-firing guns of as large caliber as 6.3 inches and converting their old breech-loaders, including those of 6.3-inch caliber, into quick firers.

Give the *Chicago*, *Baltimore* and such ships new batteries of quick-firing guns and their offensive power is immediately increased four or five fold, at least. The new battleships of the *Indiana* class are simply ridiculously weak in moderate caliber gun-fire, with only four 6-inch breech-loading guns, but give them four 6-inch quick-firers in place of them, and their moderate caliber gun-fire is immediately increased, as in the case of the other ships, four or five fold. All this being so, and I think that no well-informed person disputes it, I would ask, why are we so slow in developing 6-inch and 8-inch quick-firing guns and placing them on our ships?

In ignoring the development of private ordnance factories, and confining the construction of all naval guns excepting the small quick-firing and machine guns to the Washington Ordnance factory, have we adopted the best means of keeping in the front rank with our naval ordnance, or developing our resources, ready for an emergency? And is it not fully time for our ordnance experts to be up and moving in a determined manner to join the van?

W. V. B.

The Christmas Number of *Harper's Magazine* will contain part third of "The Martian," with six illustrations from the author's drawings. An entertaining article on "President Kruger" will be contributed by Foultney Bigelow, and Dr. William Jacques will describe the process of obtaining electricity direct from coal. W. D. Howells will give personal recollections of the Autocrat of the Breakfast Table in the article entitled "Oliver Wendell Holmes." Two well-illustrated papers will be those entitled "Wild Ducks and Tame Decoys," by Hamblen Sears, and "How the Law got into the Chaparral," by Frederic Remington. In "A Middle English Nativity," John Corbin will describe miracle-plays performed by strolling actors, in which the English drama had its beginning. There will be six short stories, a "Christmas Carol," etc. The number will be bound in an ornamental cover especially designed in colors by Howard Pyle.

The Operating Mechanism of the New Rock Island Bridge.

The new bridge over the Mississippi River, between Rock Island, Ill., and Davenport, Ia., recently opened for traffic, is a notable structure and has attracted much attention from engineers. It is the third bridge to span the river at this point in the last 40 years. The first bridge on this site was completed in 1856 and was the first bridge over the Mississippi River, and it is interesting to note that in litigation which subsequently arose from the opposition of the "river interest," Abraham Lincoln appeared as counsel for the railroad company.

In 1866 and 1867, Congress passed acts authorizing the constructing of a new bridge and the removal of the old one. The Phoenix Bridge Company was given the contract for the superstructure and in 1872 the bridge was opened for traffic. This bridge was strengthened in 1891 to meet the requirements of the increased traffic and in 1894 an entirely new superstructure and partly new masonry were authorized, and the necessary appropriation made by Congress for the construction. Mr. Ralph Modjeski was appointed Chief Engineer, tenders for the work were received on Aug. 12, 1895, at Rock Island Arsenal, by Col. A. R. Buffington commanding, and the contract subsequently awarded to the Phoenix Bridge Company.

The new bridge has two shore spans of 196 feet 6 inches and 101 feet respectively, five fixed river spans of 256 feet 6½ inches, 220 feet 1 inch, 219 feet 10½ inches, 220 feet 1½ inches, and 260 feet 4½ inches, and one draw span of 366 feet 9½ inches, making a total length of 1,841 feet 3½ inches. It is double-decked, the upper deck carrying two railroad tracks and the lower deck being devoted to a roadway with two street-car tracks between the trusses and two walks for foot passengers outside the trusses. The trusses are 20 feet centers and the total width over the side-walks is 45 feet. The trusses are calculated to carry a total moving load of 11,360 pounds per lineal foot, of which 8,000 pounds are on the railway floor and 3,360 pounds on the roadway floor. The solid corrugated steel railway floor, together with the guard angles and rail plates, weigh about 940 pounds per lineal foot of the bridge. The draw span, which weighs approximately 2,500,000 pounds, is one of the heaviest ever built.

The operating machinery of the draw was furnished by Geo. P. Nichols & Bro., Chicago, and is of unusual construction. It may be considered under four different headings.

THE SWINGING MACHINERY PROPER.

The rack attached to the tread on the center pier instead of having teeth of the usual form is made of steel with sprockets. On each side of the drum is a vertical shaft, supported by brackets, on the lower end on which are cast-steel sprocket wheels corresponding in pitch with that of the rack, which is 12 inches. These sprocket wheels carry an endless chain with links of 12 inches pitch that engage the sprockets on the rack. On the upper end of these two vertical shafts are other sprocket wheels connected by chain to vertical driving shafts which rise up to the floor of the machinery-room. An interesting feature of this part of the construction is the fact that all these vertical shafts are run on ball step bearings. On the upper end of these main vertical shafts and on a level with the machinery room floor are gears, one looking up the other looking down, the two being connected through pinions with a horizontal cross-shaft divided in the center, where an equalizing gear is attached. By means of a train of gears a 50 horse-power electric motor is connected with the shaft, thereby transmitting the power from the motor to the rack on the masonry.

RAIL LOCKS.

On the ends of the railway track on the draw is a system of rail locks consisting of heavy steel slides fitted to the outside of each rail and held in position by guides so that they may be run out or be withdrawn. When in the locked position they connect the ends of the rails on the draw with those on the fixed span, so that the wheels of the train will pass over the intervening gap on these latches, thereby eliminating any jar, as a continuous track is presented to the wheels. These latches are set and withdrawn by means of a pneumatic cylinder near each end of the

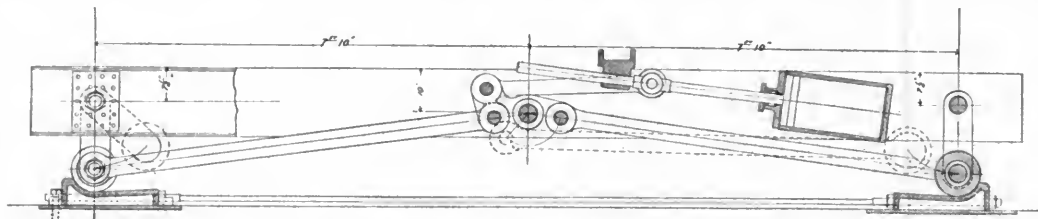


Diagram of End Jack Mechanism of the Rock Island Bridge.

draw, each connecting by a system of rods to all four latches at its end of the draw. The two cylinders are controlled simultaneously.

THE END JACKS.

The jacks themselves are the semi-toggle type consisting of two pairs of bars attached to each end of the end beams directly under the corners of the bridge. These are connected with the end beams by pins, while on the lower end are rollers which bear on bearing plates on the abutments. By means of a pneumatic cylinder and connecting struts these jacks are forced to a vertical position when the bridge is closed and are drawn in so

locked, is released. The movement of this latter lever unlocks the motor controller lever, which now being free can be moved for operating the bridge. This system makes it impossible for the operator to swing the bridge until first the rail lock and then the end jacks have been released, the indicator above referred to announcing to the operator that these various devices have gone through their movements. Inside the machinery-house is a compressor driven by an electric motor and in the attic above the machinery-room are two steel reservoirs of a combined capacity of 200 cubic feet, from which air is drawn to operate the various devices referred to. A uniform pressure of 120 pounds is maintained automatically by the pump.

The electric current for swinging the bridge is furnished from the power station of the Tri City Railway Company, whose wires pass directly over a support on the bridge, also from the People's Power Company, of Moline, whose wires are brought up to the same support on the bridge. By means of a system of rings and brushes current is taken over these wires and brought up to the switchboard in the machinery-room, where a double throw switch is placed so that the motor may be connected either with the railway wires or those of the People's Power Company.

Compressed Air in Shops.

In the last month three valuable papers on compressed air have come to our desk. One of these was presented by Mr. J.

Davis Barnett, of the Grand Trunk Railway, to the Canadian Society of Civil Engineers; another valuable contribution to the literature on the subject is the paper by Mr. Curtis W. Shields before the New York Railroad Club; and the third paper was presented to the Western Railway Club by Mr. J. H. McConnell, of the Union Pacific. We regret that the demands on our space this month do not admit of a full synopsis of these papers; as it is, we will refer briefly to them, and our readers who want complete copies can obtain them from the secretaries of the societies mentioned.

Mr. Barnett goes into the subject at considerable length. On the question of efficiency he says:

The author does not intend to say that air, for continuous work in plate flanging, or for high pressures in stamping and forging, is a more economical transmitter of power than water, or that pipes, air engines and motors are better or cheaper than wires and electric motors, or independent air-driven tools than steam applied through shafting and belts to a compact group of machine tools, but he is of the opinion that if many widely scattered, different and intermittent operations are to be performed; if a cold climate has to be fought; if the technical skill and knowledge of the workman employed is limited; and if the special and portable tools are more or less of home design and manufacture to suit the particular and limiting conditions of their use, then air has efficiency, economy and a wide field of usefulness.

After discussing various types of compressors he has the following to say about storage and pipes:

The shop piping or main for ordinary pressures (80 to 100 pounds,



The New Rock Island Bridge.

as to release the bridge when it is to be opened. The principle of the construction is shown in the diagram given herewith.

THE INTERLOCKING AND CONTROLLING SYSTEM.

A flail signal is placed on each of the fixed spans within a few feet of the ends of the draw which nominally stand at danger. Connected to each of the jacks and rail locks are electric switch boxes from which wires run to an indicator in the machinery-room. When any one or all of the jacks or rail locks are in a closed position a red lamp is lighted in the indicator, one lamp for each jack or lock, and when they are released for the bridge to swing a white lamp is lighted, replacing the red. By a combination of electric connections, the man in charge of the draw can set the signal to safety only when the heavy jack and locks are set. Thus, if for any reason the bridge is not properly locked the engineer cannot receive his signal to enter upon the draw.

CONTROLLING DEVICE.

In the front end of the machinery-room, in a bay window from which the operator can see the tracks and the river, is placed a controller consisting of four levers. The first one to the right operates a band brake applied to the machinery. The second lever controls the rail locks and can be moved at will. This being thrown forward, the lever controlling the end jacks, previously

should not be less than $1\frac{1}{2}$ inches diameter, the larger the better. The author having 4-inch pipe to spare on hand, used it with great satisfaction, as it gave ample storage and little friction. Very slight provision is required for drainage. The main is best carried on the top of the roof tie-beam, and from the first should be liberally supplied with short branches and outlet valves, at least one to every 18 or 20 feet, with screwed ends to fit the union nuts of the flexible hose, the hose for hand tools and hoists varying from $\frac{3}{4}$ to $\frac{1}{2}$ inch diameter. Cords from the outlet valve lever run down to within seven feet of the floor, controlling the position of the valve. Reservoir storage has to be proportionately, the larger the more intermittent the work done. The pipes and reservoir together should be capable of holding the total delivery of the compressor (working at normal speed) for half an hour, which is far cheaper than providing an excessively large size compressor, cheaper not only in first cost but in daily working. This refers to steam-power compressors.

Mr. Barnett then shows how great is the saving in labor by the use of compressed-air appliances, and proceeds to discuss rotary and reciprocating piston motors. He considers that while the use of rotary motors has been stimulated by the introduction of air, little advance has been made in their design. They are wasteful of air, but their convenience retains them in use. He uses portable double acting vertical engines, with cylinders $3\frac{1}{2}$ by 6 inches, running at 225 revolutions. He reheats the air as follows:

Just before it enters the valve chest, it is passed through a 30-inch length of thin copper pipe, $\frac{1}{2}$ inch outside diameter, bent into a four-turn truncated coil, barely $3\frac{1}{2}$ inches diameter at base and $2\frac{1}{2}$ inches diameter at top, contained in a tin lamp 12 inches long, by $3\frac{1}{2}$ inches diameter at bottom and $1\frac{1}{2}$ inches diameter at top. The lamp cistern carries a double "B" burner, using two $\frac{1}{2}$ -inch flat wicks, and burns an imperial pint of common coal oil each 30 hours. No glass chimney is required, and the flames come close to inside of coil. This lamp it boited on close to and parallel with the cylinder, and is cheap, neat and inconspicuous, working satisfactorily, even when the engine is set at an angle of 15 or 20 degrees out of vertical.

The paper by Mr. Shields is devoted largely to a consideration of the economical compression of air. The losses due to heating during compression, to clearance in the cylinders, and to friction in the compressor are all discussed at length, and the methods by which these losses are reduced to a minimum in the modern first-class compressor are pointed out. Diagrams of isothermal and adiabatic compression are given, also curves of volumes, pressures and temperatures; tables of temperatures and heat losses in compression carried to various pressures; tables of air used in motors per indicated horse power, and much other valuable data of a similar character. Various authorities are quoted on the cost of compressing air, reheating and other features of good practice. The cost of 1,000 cubic feet of free air compressed to 100 pounds (gauge pressure) is given as 5 cents, including all charges and with coal at \$4 per ton. Reheating is considered of great importance where motors are used continuously for any length of time, and a horse power at the reheater can be obtained for one-eighth the fuel required for a horse power at the compressor. The advantages of multiple-stage compression are elucidated, and the paper closes with a quotation from the practice of Mr. McConnell, in the Union Pacific shops, showing the saving per day in labor at various points in the shops where air is used.

Mr. McConnell's paper comes to us just as we go to press, and in terse language gives many valuable hints on the application of air. Lifts, jacks, drills, staybolt cutters, and many other devices are mentioned; also the use of air for driving emery wheels, for blowing out cylinder passages, for moving locomotives between the erecting shop and roundhouse by charging their boilers with air, for driving scrap shears, for stamping in the tin shops, for the blast of portable forges, for operating portable engines, for raising sand in the sand-houses, for kindling locomotive fires, for the blast for fires in the blacksmith shop, etc., etc. These are all touched on and enough said about them to show how the applications can be made by those who desire to extend the use of air in their own shops.

The *Street Railway Review* of Chicago will on January 1, 1897, begin the publication of a foreign edition which for the present will appear quarterly. The interest now manifested in other countries in the use of electricity for street railway work is the immediate occasion for this step, as it is believed that the development of that industry in the United States, and the experience gained here, should prove valuable abroad, and should predispose managers and engineers to favor American methods, systems and special devices. This is a reasonable expectation, and we wish our contemporary success in its new venture, and American manufacturers an influx of foreign orders as a result of it.

Powerful Compound Locomotives for the Northern Pacific Railway.

The Schenectady Locomotive Works are building for the Northern Pacific Railway Company four Mastodon or 12-wheel compound locomotives, which will be the most powerful engines of this type ever constructed.

The engines are of the Schenectady two-cylinder compound type, the high-pressure cylinder being 23 inches and the low-pressure 34 inches in diameter, with a stroke of 30 inches. The cylinders are fitted with the new intercepting valve, designed by the Schenectady Locomotive Works, which enables the engine to be operated as simple or compound at will, this device now being in very successful use.

The weight of the engine will be about 180,000 pounds, with 148,000 pounds on drivers. The driving-wheel centers are of cast steel, 48 inches in diameter, which with 34-inch tires makes the diameter of drivers 55 inches.

The boiler is of the extended wagon-top type, 72 inches in diameter at the front end, has a larger heating surface than ever used in locomotive practice, and is built to carry a working pressure of 200 pounds.

Discipline Without Suspension.

In an excellent paper on discipline Mr. H. S. Mitchell, Division Superintendent of the Kansas City, Fort Scott & Memphis Railway says that when discipline without suspension was first tried on his road he was doubtful of the efficacy of the system in dealing with men who take no pride in their work. He found afterward that it was just this class of men on whom the discipline had the greatest effect. He says: "But how about the man who is generally careless, who does not take pride in his work? It was on this very point that I was doubtful myself, and when the circular to Memphis employees announcing the change of discipline was being prepared, I urged the insertion of the following clause: 'Suspensions will be imposed when the head of the department deems disciplining by marks unsuitable to the case or to the individual.' But with the experience I have since had, I am perfectly willing to surrender this reservation, believing now that suspensions are not necessary to effect proper discipline among even second-rate men. In fact it is this class that seem to take the matter most seriously, evidently looking upon it as a scheme of their superiors to get rid of them. They, of course, regarded suspension as an undesirable thing, but entertained the idea that, having undergone a suspension, they were thereby purged of all guilt and entitled to a fresh start. They now realize that while they escape suspensions, the offenses that were formerly punished in that way are treasured against them, and that eventually each offense, treated so indulgently at the time of its commission, will contribute in a measure to causing their dismissal. They discover that trivial offenses, never considered sufficient to warrant suspension, are now recorded and are liable to prove the straw that breaks the camel's back. Perhaps in no other particular is the advantage of the new system so pronounced as in the matter of disciplining for small irregularities, and as a result we observe a marked decrease in the number of slight, but vexatious, blunders. Another desirable feature is the opportunity afforded an officer to reverse or amend his ruling in particular cases, if, after the lapse of time, he finds that he has erred, or that evidence not obtainable at the time of the original investigation places the matter in a different light."

One of the elevators in the American Tract Society's 23-story building in New York City, one day last month dropped 140 feet at a speed just too slow to throw the safety clutches into action. The elevators are on the high-pressure system and have given considerable trouble. They have a total lift of 267 feet 7 inches, and a speed of 700 feet per minute. The trouble with the high-pressure system is said to be that the small volume of water required for the work makes fine regulation very difficult and the new valves designed for the system have not worked as well as expected. The immediate cause of the accident was the blowing out of packing by which the water was allowed to rush out of the cylinder. The elevators are to be altered over to the low-pressure system.

(Established 1832.)

AMERICAN ENGINEER CAR BUILDER AND RAILROAD JOURNAL

27TH YEAR.

65TH YEAR.

PUBLISHED MONTHLY

BY
R. M. VAN ARSDALE,

MORSE BUILDING.....NEW YORK.

M. N. FORNEY,
W. H. MARSHALL, } Editors.

R. G. CHASE, 705 Western Union Building, Chicago.

DECEMBER, 1896.

Subscription.—\$2.00 a year for the United States and Canada; \$2.50 a year to Foreign Countries embraced in the Universal Postal Union.

EDITORIAL ANNOUNCEMENTS.

Advertisements.—Nothing will be inserted in this journal for pay, EXCEPT IN THE ADVERTISING PAGES. The reading pages will contain only such matter as we consider of interest to our readers.

Special Notice.—As the AMERICAN ENGINEER, CAR BUILDER AND RAILROAD JOURNAL is printed and ready for mailing on the last day of the month, correspondence, advertisements, etc., intended for insertion must be received not later than the 25th day of each month.

Contributions.—Articles relating to railway rolling stock construction and management and kindred topics, by those who are practically acquainted with these subjects, are specially desired. Also early notices of official changes, and additions of new equipment for the road or the shop, by purchase or construction.

To Subscribers.—The AMERICAN ENGINEER, CAR BUILDER AND RAILROAD JOURNAL is mailed regularly to every subscriber each month. Any subscriber who fails to receive his paper ought at once to notify the postmaster at the office of delivery, and in case the paper is not then obtained this office should be notified, so that the missing paper may be supplied. When a subscriber changes his address he ought to notify this office at once, so that the paper may be sent to the proper destination.

The paper may be obtained and subscriptions for it sent to the following agencies: Chicago, Post Office News Co., 217 Dearborn Street. London, Eng., Sampson Low, Marston & Co., Limited St. Dunstan's House, Fetter Lane, E. C.

CONTENTS.

ILLUSTRATED ARTICLES:	Page.	MISCELLANEOUS.	Page.
A New Freight Draft Gear.....	320	Electric Traction Under Steam	326
Abrasion Tests of Iron and Steel	322	Railway Conditions.....	326
Cambria Iron Co.....	322	Water Spray Firing.....	328
Locomotive for a Six Per Cent.	324	Fire-Resisting Qualities of Gra-	328
Grade—P. C. & St. L. Ry.....	324	phite Paint.....	328
The Operating Machinery of the	329	The Needs of Our Navy.....	328
Rock Island Bridge.....	329	Compressed Air in Shops.....	330
Construction and Maintenance of	335	Powerful Locomotives for the	331
Railway Car Equipment.....	335	Northern Pacific Road.....	331
Locomotives Recently Con-	339	Discipline Without Suspension..	331
structed by the Baldwin Loco-	339	Personals.....	335
motive Works.....	339	Citizenship and Technical Edu-	345
Grate for Burning Fine Anthra-	313	cation.....	345
cite—D. L. & W. Ry.....	313	Explosive Properties of Acety-	314
The Most Advantageous Dimen-	347	lene.....	314
sions for Locomotive Exhaust	347	Corrosion of Metal Tender Frames	314
Pipes and Smoke Stacks.....	347	Electricity as Applied to Traction	316
The Q. & C. Pressed Steel Brake-	353	New Publications.....	316
shoe Key.....	353	Cost of Repairs to Electric Street	346
EDITORIALS:		Cars.....	346
Cast Iron vs. Steel-Tired Wheels	332	Trials of the Pneumatic Machinery	346
The Movement for the Adoption	332	on the U. S. Monitor Ter-	346
of a Standard Freight Car.....	332	rrior.....	346
Defects and Improvements in	333	Arbitration Committee Decis-	347
Locomotives.....	333	sions.....	347
Prospects for Electricity on	334	The Situation in China and	351
Steam Roads.....	334	Japan.....	351
MISCELLANEOUS:		The Society of Mechanical En-	351
The Altoona Shops of the Penn-	317	gineers.....	351
sylvania Road.....	317	Association of Ry. Supt. Bridges	351
The Value of a Steam Jacket on	321	& Bldgs.....	351
a Locomotive.....	321	Trade Catalogues.....	352
More Engineer Officers Required	325	Equipment Notes.....	352
in the Navy.....	325	The Roberts Water-Tube Boiler.	353
The June Conventions for 1897.	325	Manufacturing Notes.....	353
The Baltimore & Ohio Tunnel	325	Our Directory.....	354
Plant.....	325		

There appeared in our columns last month an abstract of a comparison between steel-tired and cast-iron wheels, presented recently to the Southern and Southwestern Railway Club. By that comparison the steel-tired wheel was shown to be much less economical than its competitor. There is no doubt that for many kinds of service the cast-iron wheel is the cheaper of the two, but it is a question if the difference is always as great as the figures given in the comparison referred to would indicate. To make a comparison upon the mileages guaranteed the respective wheels is not so accurate a method as if the actual average mileages are taken, unless it can be shown that the guaranteed and actual mileages bear the same ratio to each other. There are those who believe that the actual mileages of the steel-tired wheels exceed their guarantees to a greater degree than do cast-iron wheels. There is also the number of wheels discarded because of flat spots or other defects to be considered, and which does not seem to have been taken into account in the paper mentioned. The question of safety is also an important one, and while the high-grade cast-iron wheel is a product that does credit to the foundryman, and is remarkable for its freedom from fracture in service, there are positions in which railroad men are loath to trust it. In heavy fast passenger service the coaches will be found to be carried upon steel-tired wheels, even if the cast-iron wheels are used under other coaches on the same road. The truck wheels of fast passenger engines are steel tired. Freight engines may have cast-iron truck wheels when the leading trucks have four wheels, but if the engine is of the Mogul type a steel-tired wheel is often substituted. Other cases might be cited, but these are sufficient to show that reliable as is the cast-iron wheel when properly made, the steel-tired wheel is considered preferable under conditions that are unusually severe. We are of the opinion that if accurate statistics on the safety and service of the two types are collected for various classes of service, instead of lumping them all together, the results will show that railroads have good reason to use steel-tired wheels in some classes of service, and that there is a wide field of usefulness for both types of wheels.

An important movement having for its purpose the establishment of standard 60,000-pound box car, into which shall be incorporated all the Master Car Builders' standards and recommended practices, has been inaugurated by the Ohio Falls Car Manufacturing Company, of Jeffersonville, Ind. That company does not expect that this movement will change the standards of large systems, but it may be instrumental in bringing about a uniformity in the freight car equipment that is hereafter to be required by smaller roads and private companies, who wholly or in part accept the specifications of the builder. Such a result is well worthy the hearty co-operation of every railroad company and of Master Car Builders and foremen, as every shop must repair these cars, and they should welcome any progress toward simplifying their present diversity. The other car building firms throughout the country have been invited to join in the movement and to signify their preferences in the following dimensions of the proposed standard: Length, width and height, in the clear inside; door opening; center to center of body bolsters; section of each sill, end sill and plate; height of lining; diameter and ends of truss rods; wheel spread; section and set of each arch and tie bar; diameter of column and oil box bolts.

The originators of this plan believe that this movement will result in creating a uniformity among the contract car works, primarily of the parts mentioned, and later of many of the less essential parts, as well as of the details of fruit, coal, stock and flat cars. The standard can be kept up to date by incorporating all standards as successively adopted or recommended by the Master Car Builders' Association or by the united judgment of the manufacturers. The plan is to be commended, and we think it would be a fortunate thing for the railroads of this country if it should ultimately result in a standard design in which each and every detail is included and which would be followed by more than the small roads. The large roads should be interested in this movement by reason of the prospective reduction of the

diversity that now exists; and if the movement succeeds their passive interest may turn to an active one and they may be induced to join it. They have frequently been urged to take steps themselves toward the adoption of a standard car, but as yet have failed to do so. In fact, they have never seriously entertained the matter, and so we have in the country a million and a quarter of cars of thousands of different designs, few of them confined to any one locality, and some of nearly every design, ultimately passing through every repair shop in the land. There is no necessity for so many designs, particularly in the cars that are extensively interchanged, and if wisely designed standard cars are once thoroughly established their adoption ought to extend rapidly. The movement inaugurated by the Ohio Falls Car Manufacturing Company is deserving of hearty support.

DEFECTS AND IMPROVEMENTS IN LOCOMOTIVES.

III.

In our September number this subject was partially discussed with an announcement that its consideration would be resumed in a future number. The sources of waste which were then pointed out were imperfect combustion, due in part to bad firing; defects in grates and small fireboxes, and to the excessive temperature of the escaping chimney gases and the heat in the exhaust steam. The remedies which were then suggested were the improvement of firemen, larger fireboxes and grates, variable grates in which the live and dead portions could be varied at pleasure and devices which would bring about a more intimate contact of air with the fuel to be burned, feed-water heaters and steam superheaters. Down-draft grates were also proposed as worthy of investigation.

The great deficiency in most of our large locomotives of the present day is in the size of their fireboxes. With our bar frames 3 or 4 inches wide, if the firebox is placed between the frames, the width of the grate cannot exceed about 35½ inches. If the firebox is placed above the frames the grate may be about 8 inches wider, but the depth over it must be considerably reduced. The Wooten type of firebox, which is placed entirely above the driving wheels, can then be made as wide as the widest part of the engine, but it must then be very much reduced in depth. This is a measure compensated for, in some cases, by making it long and using a bridge wall and thus forming a combustion chamber at the front end. Still the fact remains that the fire, in this kind of firebox, and in less degree in the so-called "toboggan" form, which is above the frames, is brought comparatively near to the crown-sheet. Now, in any fire, but especially one which is burned as rapidly as that in a locomotive grate is, it is very important that the process of combustion should be as near completed as possible before the flame or gases come in contact with the heating surfaces. Such contact undoubtedly partially arrests combustion. Plenty of room in the firebox, especially above the grate, is, therefore, regarded as a matter of much importance, and as promotive of good combustion.

Twenty-five or thirty years ago the standard passenger engine in this country weighed about 30 tons, and had about 15 square feet of grate and about 800 square feet of heating surface. Now our passenger engines, many of them, are of double that weight, and have twice that amount of grate and heating surface, and the average speed of trains has been increased about 50 per cent. and their weight doubled. To haul twice the weight at a given speed will require double as much steam and at a speed 50 per cent. greater, the train resistance will be increased about one-third. Now, if the old 30-ton engines burned 24 pounds of coal per minute to haul their trains at 30 miles per hour, the big engines should burn twice as much, or 48 pounds, to haul a train of double the weight. If, besides, the speed is increased 50 per cent., the quantity of steam consumed in a given time would be in the same proportion, which would require a consumption of coal of 72 pounds per minute, and as the train resistance would then be one-third greater at the increased speed, we would have a total consumption of 96 pounds of coal per minute. That is, with double the grate and heating surface, we must burn four times the quantity of coal

in a given time that the old engines did. The figures are, of course, only assumptions and are used merely as illustrations, but they will explain, what has often been remarked, that our modern locomotives do not do the amount of work in proportion to their size that the old engines did "before the war." In other words, the locomotives of to-day are deficient in boiler capacity. Now, how can the boiler capacity be increased? Obviously the limitations are those of space and weight. We are confined in width and length and height, and the weight which can be carried on each wheel must not exceed a certain amount. The problem is a very old one, and the ingenuity of designers of locomotives has been exercised on it ever since the latter have outgrown their limitations. The plan, which seems to be a solution of the difficulty—at least in the case of passenger engines—is that embodied in the "Columbia" type of engine, in which the driving-wheels are all placed in front of the fire-box and the overhanging weight of the latter is carried on a pair of small trailing wheels. By depressing the frames back of the driving-wheels and carrying them below the firebox, it can be made of a reasonable depth or height, and of any width desired. But if the wheels are large, say 7 feet diameter, even if they are placed as close together as is practicable, the boiler, if arranged as in ordinary locomotives, must be very long and the tubes will be about 15 feet in length, unless the front tube sheet is set back farther than is customary. While long tubes would have the advantage that they would facilitate the use of the method of heating feed-water, which was described in our preceding article, and would give considerably more heating surface, their greater length and that of the boiler would increase its weight very materially. The problem, then, is how to reduce the weight either of the boiler or other parts of the locomotive so that its total weight will not exceed the limits to which it must of necessity be confined?

We are thus confronted with very much the same problem which Ross Winans wrestled with in the early days of the Baltimore & Ohio Railroad, when he first began to build eight-wheeled coupled engines for that road, which had very sharp curves and heavy grades. His "camel" engines had wheels 43 inches in diameter, and a total wheel base of 11 feet 2½ inches. All the axles run in front of the firebox, the outside width of which was just sufficient to allow its front end to go between the back pair of wheels. The boiler had 103 tubes, 2½-inch tubes 14 feet 1½ inches long. The grate was 7 feet long by about 42 inches wide. The weight of engine with water and coal is given at 24 tons; whether long or short ones does not appear in the records available. The diameter of boiler was 46 inches. The heating surface in the tubes was 903 square feet, and in the firebox 86½, or a total of 989½ square feet. With that size of boiler and weight of engine, it will be seen that it was not an easy problem to keep the weight down to the limitations to which they were then confined. The top of the firebox was therefore made to slope downward from the point where it joined the waist of the boiler to the back, and the top was made flat and stayed with ordinary stay-bolts. It is doubtful whether any locomotive boiler of equal capacity was ever made which weighed so little. Unfortunately its weight is not now known. It is true that many of them exploded, but that was probably owing to the deficient staying at the base of the dome, which was very large, and located just back of the front tube-sheet. This same form of firebox was afterward adopted and is still extensively used in the Pennsylvania Railroad, although no new engines with boilers of that form are now built. It has given excellent service, and by those who have had the best opportunities of learning and knowing, the writer was recently told that there was no boiler on the road which weighs and costs so little, in proportion to its capacity or is so economical to maintain or has given better service than this. Some of them were originally made too small, which was not a defect in their form, but in their proportions. There can be no doubt that a very material saving in weight can be effected by using this form of boiler.

There is another consideration which has not a sufficient amount of attention in locomotive designing, which is, that for every

pound of weight saved in the other parts of the machine, a pound may be added to that of the boiler. The substitution of steel and wrought-iron parts for those heretofore made of cast iron has made a very great economy in this direction possible, and it seems certain that if a skillful designer should carefully go over every part of any ordinary locomotive and remove all unnecessary material that a very considerable reduction would be possible, without any diminution in strength, and possibly by some intelligent design in some cases an increase in strength. The use of cast-steel wheel centers reduces their weight some hundreds of pounds, and if some genius would devise a method of counterbalancing the pistons, cross-heads, etc., without the use of counterweights, several thousands of pounds more of useless weight could be dispensed with.

An essential requirement in locomotives of to-day is larger fire-boxes and greater boiler capacity. The plan of placing the driving wheels all ahead of the fire-box, and carrying it on a pair of trailing wheels, enables the fire-box to be increased in width without material diminution in depth. The old discarded and discredited, but nevertheless efficient, form of fire-box described, will permit of a very material diminution in weight over any other form in use. There is also the consideration that the nearer an apartment approximates in plan to a square the smaller will the walls be for a given enclosed area. Thus supposing we have a grate 4 by 12 feet the length of the enclosing walls would be 32 feet and the enclosed area 48 square feet. If the grate was 8 by 8 feet the enclosing walls would have the same length, but the area would be 64 square feet instead of 48. The enclosing walls of a fire-box which is nearly square, will, therefore, weigh less for a given grate area than they would if the grate is long and narrow. This same principle applies with reference to the cubical contents of a fire-box—an important matter. The nearer it conforms to a cube, that is, the nearer the length, breadth and height are alike, the lighter will be the enclosing walls in proportion to its cubical contents.

Of course, if it was practicable to make a fire-box spherical in form, it would be the lightest possible shape that could be adopted. It will be seen, then, that the "Columbia" plan of engine not only permits the fire-box to be enlarged laterally and vertically, but it may at the same time be made lighter for a given area of grate. By adopting the Winans' or camel fire-box, with the "Columbia" type of engine, the weight which overhangs behind the driving axles could be lightened, or, conversely, its size may be increased without adding to its weight. The purpose of this article, then, is to call attention to the advantages which are inherent in the "Columbia" plan of engine and the camel fire-box or something similar to it.

The subject of this article will be taken up again in a future number.

THE PROSPECTS FOR ELECTRICITY ON STEAM ROADS.

In discussing last month the immediate prospects for electricity on steam roads we referred to the paper on the subject which had been presented before the electrical engineers in October and the discussion which took place thereon. Mr. Emery, in his paper published elsewhere in this issue, says that the use of electricity for long-distance traffic is feasible, and the real question is whether it will pay. He shows that in city and suburban traffic electricity is an established success and one feature of it is the increased travel which has been created by it. In long-distance traffic he holds there is little probability of increasing the amount of travel and that electricity must compete with steam on the basis of the same amount of business for both. He further believes that the electric locomotive for high speeds will eventually resemble the steam locomotive more than it does now. In his opinion it will be advisable to mount the motor separately and gear it to a shaft from which the power will be transmitted to the driving wheels by connecting and parallel rods. The leading truck he also believes will be needed to give flexibility and security at high speeds.

So much for the conditions of the problem and the tendencies in electric-locomotive construction. He then proceeds to com-

pare the actual figures for an Eastern trunk line with a possible electric installation to handle the same traffic. The first item of importance in many of the discussions on this subject is the saving in fuel, but he shows that on the steam road the fuel bill is only 10 per cent. of the total expenses and that, therefore, if one-half of it was saved the actual reduction of expenses would be only 5 per cent. As an actual fact this saving will be swallowed up by fixed charges and an additional traffic of from 10 to 12½ per cent. will be needed to wholly meet these charges.

In the discussion which followed, these figures were not challenged, but there appeared to linger in the minds of several prominent electricians the hope that if electricity did not pay in dollars and cents in such traffic it might ultimately succeed because of other advantages accruing from its use, such as increased power and greater speed than is possible with the steam locomotive, and the possibility of more successfully operating traffic in small units. Now, much as one may desire to see electricity a success in long-distance traffic, nothing is to be gained by glossing over facts, which is what is done by those who present such arguments.

Take the question of the weight of trains. The tendency toward heavier train loads is one of the characteristics of the progress being made toward cheaper transportation on steam roads to-day, and it is based on sound principles. As Mr. Emery shows, the fuel consumption is but about ten per cent. of the operating expenses, and experience shows that heavier trains in general reduce the other operating expenses, such as wages, etc., more than they increase the fuel consumption. Instead of undertaking the long-distance traffic with reduced train loads, the electrician should in most cases be prepared to haul heavier trains than at present. The strenuous efforts now being made by railway managers to get more tonnage in each car and more cars in each train is a fact the significance of which should not be overlooked.

As to the increase of speed possible with the electric motor, it is of questionable utility. Increased speed always means increased cost, and there seems to be no reason why this should not apply equally to electricity and steam. On this assumption, it is reasonable to suppose that the increased speed is not wanted for freight service, and if wanted can be obtained with steam as readily as electricity. In passenger service the steam locomotive can attain any reasonable speed, and the enormous velocities claimed to be possible with electricity would call for such large expenditures for brakes, signals, etc., as to render the speeds impracticable, particularly if the slow-moving freight trains are to be operated on the same line.

Nor does the claim for greater power in the electric motor seem well founded. If the weight of the locomotive can be increased, greater power can be obtained with steam. Unless it can be shown that for a given weight the electric locomotive can develop more power than its competitor, the greater power is not available. The experience thus far gained would seem to indicate that instead of weighing less, the electric motor will weigh more when it carries all the accessories that are necessary for economical operation.

It is matter of regret that any prominent electricians can be found who are ready to defend such an unmechanical affair as the Heilmann locomotive, or to express the belief that some good may come from the experiments with it, as was done in the discussion referred to. The motive power at the head of a train is fairly satisfactory when it consists of a boiler and a steam engine, and it may be a success when it is made to consist of an electric motor, but when it carries all of these and dynamos in addition it is doomed to failure.

The conclusion seems inevitable that electric motive power, to be successful in long-distance travel, must be superior to steam in dollars and cents, and must haul trains of the present, or heavier, weights on existing schedules.

The idea that compressed air mixed with steam in the cylinder of a steam engine would be productive of economy has been endorsed in times past by engineers of eminence. Some ground for

this belief exists in the known fact that the presence of the air in the steam decreases the amount of cylinder condensation. To find the exact effect of such a mixture upon the economy of an engine tests were recently undertaken at Stevens Institute (and published in the *Stevens Indicator*), the engine used for the purpose having a single cylinder $7\frac{1}{2}$ inches in diameter and 14 inches stroke, running from 200 to 228 revolutions per minute and cutting off at one-quarter of the stroke. The tests were in four series, as follows: 1st, Tests 1 and 14, using steam alone; 2d, Tests 2, 2A, 3 and 4, using air and steam, the air at a temperature of 70 degrees; 3d, Tests 5, 6 and 7, using steam and air, the air being heated to about 540 degrees Fahr., corresponding to the temperature of adiabatic compression; 4th, Tests 8 and 9, under the same conditions as 5, 6 and 7, except that the air orifice was enlarged to twice its original diameter. The steam-pressure averaged about 90 pounds. In series 2 and 3 the air entered the steam-pipe through a hole $\frac{1}{16}$ inch in diameter and in series 4 the orifice was $\frac{1}{2}$ of an inch. The air admitted varied from 14 per cent. (by weight) of the steam to 84 per cent. The indicated horse-power averaged about 20. The water per indicated horse-power, without air, averaged 32 pounds. When air was used it averaged 30.7 pounds. The best results gave a saving of about 7 per cent., but this is almost exactly offset by the power required to compress the air, so that the saving per net horse-power is nil.

Personals.

Mr. H. T. Woods has been elected General Manager of the Tabor & Northern Railway.

Mr. W. W. Noble has been appointed Purchasing Agent of the Huntington & Broad Top Railway, vice Mr. S. B. Knight, resigned.

Mr. Joseph S. Harris has been chosen President and Mr. William R. Taylor Secretary of the reorganized Philadelphia & Reading Company.

Mr. George Hafer has retired from the presidency of the Cincinnati, Lebanon & Northern, and is succeeded by Mr. Joseph Wood, of the Pennsylvania lines.

Mr. George C. Gorham, of Washington, for many years Secretary of the United States Senate, has been elected a Vice-President of the Northern Pacific Railroad.

Mr. W. W. Tomlinson has been appointed Chief Engineer of the New Orleans & Western, with headquarters at New Orleans, La., to succeed Mr. C. B. Deason, resigned.

Mr. J. T. Odell has resigned as Second Vice-President of the New England Railroad, so that he can devote all his time to the Butler & Pittsburgh, of which he is President.

Mr. Wm. H. Stocks has been appointed Division Master Mechanic of the East Iowa Division of the Chicago, Rock Island & Pacific Railway, with headquarters at Rock Island.

Mr. Volney T. Malott, of Indianapolis, Ind., has been appointed Receiver of the Vandalia system. Mr. Malott is Chairman of the Board of Directors of the Chicago & Western Indiana.

Mr. B. A. Denmark, of Savannah, has been elected President of the Southwestern Railway, to succeed the late President Baxter. Mr. Denmark has been a Director of the Central of Georgia.

The Marietta & North Georgia road has been reorganized as the Atlanta, Knoxville & Northern, and Henry K. McHarg has been elected President, Mr. Eugene C. Spaulding, Vice-President, with headquarters at Atlanta, and Mr. Joseph McWilliams, General Manager, with headquarters in the same city.

Mr. John M. Egan has been elected Vice-President of the Central Railroad of Georgia and will have his headquarters at Savannah, Ga. Mr. Egan has occupied many important railroad positions with ability, among them the Presidency of the Chicago Great Western, and in that position he was the Agent of the General Managers' Association at Chicago during the Debs strike.

Mr. George F. Ely, Secretary and Treasurer of the Cleveland City Forge and Iron Company, died suddenly on Oct. 28. Mr. Ely began his business career in the office of his father, who at that time was Treasurer of the Lake Shore road. In 1864 he entered the firm of Coe, Ely & Harman, which in 1871 was incorporated as the Cleveland City Forge and Iron Company. At the time of his death he was also interested in several other manufacturing interests.

The promotion of Mr. Atterbury from Fort Wayne, to be Superintendent of Motive Power at Altoona has led to several other changes in the Mechanical Department of the Pennsylvania system. Mr. Bernard Fitzpatrick, Master Mechanic of the Pennsylvania lines at Columbus, O., has been appointed Master Mechanic at Fort Wayne, Ind., to succeed Mr. Atterbury; Mr. Thomas F. Butler, Master Mechanic, at Wellsville, O., has been transferred to Columbus, O., to succeed Mr. Fitzpatrick; Mr. George P. Sweeley, Master Mechanic at Crestline, O., has been transferred to Wellsville, O., and Mr. P. F. Smith, Jr., Assistant Master Mechanic, of the Fort Wayne shops, has been appointed Master Mechanic at Crestline, O., to succeed Mr. G. P. Sweeley.

Gen. Joseph T. Torrence, well known in railroad circles through his connection with the Chicago & Western Indiana road and through the part he took in track elevation in Chicago, died in Chicago, Oct. 31, in the fifty-fourth year of his age. He was born in Mercer County, Pennsylvania, and was early thrown on his own resources. He was working as foreman in the Briar Hill iron furnaces at the opening of the war, which position he resigned to enlist in the army. After his return from the war he took charge of iron furnaces in Pennsylvania and in 1869 went to Chicago as Manager of what is now the Union Works of the Illinois Steel Company. From that time on he was interested in many iron plants in the vicinity of Chicago. He also in the early eighties took the presidency of the Chicago & Western Indiana and helped to build up that line. He was also one of the promoters of the Chicago & Calumet Terminal Railway. In recent years his magnificent scheme to construct an immense elevated terminal system for all the roads entering Chicago from the south brought him more prominently before the public than ever. His terminal plans were not realized, but much of the credit for the work of track elevation since accomplished in that city is due to the energy with which he grappled with the problem.

CONSTRUCTION AND MAINTENANCE OF RAILWAY CAR EQUIPMENT.—IX.

BY OSCAR ANTZ.

(Continued from page 254.)

FREIGHT TRUCKS—CONTINUED.

In Fig. 53 is shown a diamond truck which differs in a number of points from those described in the previous articles. The spring-plank is discarded and the two sides of the truck are connected by two channel bars placed vertically, which also form a guide for the bolster, doing away with the usual guide bars and blocks. A, B and C are the arch and tie bars, which are connected together in the usual manner by the arch bar bolts DD and journal-box bolts EE, a malleable washer OO being placed under the heads of the former to allow for good fillet to be left on the bolt. On top of the bottom arch bar at its center is placed the spring seat FF slipping over on the sides of the bar, and also slipping up over the outsides of the transoms GG. These channel iron transoms are placed between the top of the spring seat and bottom of top arch bar and the whole is securely tied together by means of the arch-bar bolts DD, malleable castings HH being riveted to the channel bars, and forming a support for the bolts. This casting is extended toward the center of the truck and forms a bracket for the brakebeam hangers. The bolster II is of oak in two pieces bolted together and trussed by the rod JJ, for which grooves are cut out in each half of the bolster, this rod passes under a deep queen post PP at the center and the nuts on the ends rest on large cast-iron washers NN, which distribute the

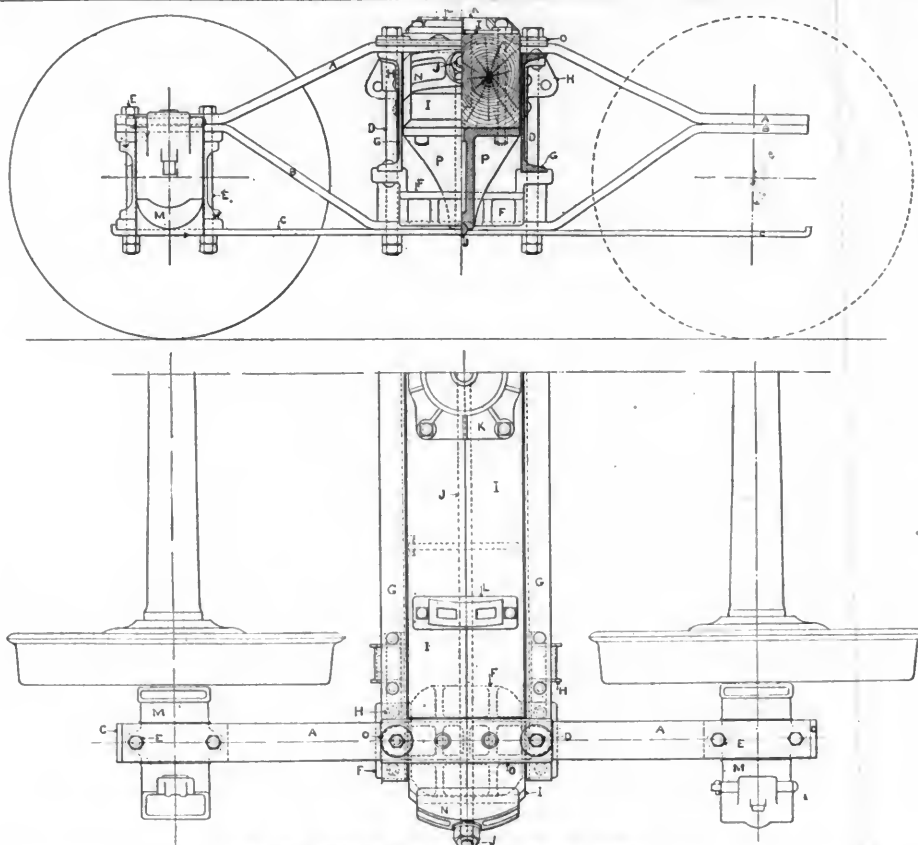


Fig. 53.—Diamond Truck without Spring Plank.

strain over the ends of the bolster. The top of the bolster near the ends is cut down about 2 inches so as to allow the ends to pass under the arch-bars and the shoulders thus formed limit the end motion of the bolster, the side motion being restrained by the transoms. Center plate *K* and side bearings *LL* are provided in the usual manner. The journal boxes *MM*, shown on these plans, are rounded on the bottom, thereby doing away with corners, which would have to be filled with waste and oil which is not utilized in the lubrication of the journal.

PRESSED STEEL IN TRUCK CONSTRUCTION.

On account of the extreme weight of trucks, attempts are constantly being made to lighten their construction without impairing the strength, and pressed steel seems to be the material which allows the greatest reduction in the weight. Bolsters and spring planks made of pressed steel were mentioned in previous articles, and recently arch bars have been introduced which are made of pressed steel of channel construction, instead of solid bars of iron, but as yet these have been so little used that their success is still a matter of doubt.

Trucks, made of pressed steel, and differing in their entire construction from the diamond truck, are being used considerably and have given such excellent satisfaction that many roads have adopted them quite extensively. While the repairs of these trucks, when badly damaged, are perhaps difficult to make, still it is matter of fact that they are not as easily damaged as the diamond truck, and their economy is therefore at least no less. In these trucks the springs are placed directly above the journal boxes and the truck rests on top of these springs, pedestals being provided by means of which the relative position between frame and boxes is retained. The entire frame of the truck is riveted together, forming practically one piece.

In Fig. 54 is shown working drawings of the Fox truck, which is

used the most in this country. The side frames *AA* are pressed in the shape of channel-bar section and are riveted to the two transoms *BB*, which are also of channel-bar section, the flanges on the ends being cut off and these ends being turned to form a right angle, providing the means to attach the transoms to the side frames. The two transoms are tied together by the center-stiffener *G* and by the strut *F* and base plate *C*, the two latter also forming a support for the center plate *D*. All these parts are made of pressed steel, and are riveted together. The side-bearings are supported by the side-bearing struts *HH*, which also help to tie together the two transoms. *II* is a bracket for attaching the brake-beam hanger, when inside-hung brakes are used.

The side frames are cut out at the axle centers, to receive the pedestal *T's EE*, which guide the journal boxes in their vertical motion. In the top of these pedestals are placed the top spring seats, which receive the truck springs, and the bottom of the pedestals is tied together by means of the bolts *K* passing through spread pieces *JJ* of cast-iron. All the parts which are made of pressed steel, are $\frac{3}{4}$ inch thick, and the rivets used are $\frac{1}{2}$ inches in diameter. Brake lever guides and fulcrums and safety chains can be attached wherever desired, as is shown on the perspective views.

Fig. 55 shows another pressed steel truck, the Schoen, which differs greatly from the one just described, in the shape of the separate parts and in the introduction of a stiffening piece of bar iron or steel.

AA are the top members of the frame, which also form the outer legs of the pedestals. *BB* are the bottom members, made of flat bars, and riveted to the top members at the ends over the journal boxes. These bottom members pass down on the inside of the pedestals and under the side frame diaphragms *CC*. The pedestal brackets *DD* are riveted to the bottom of the lower

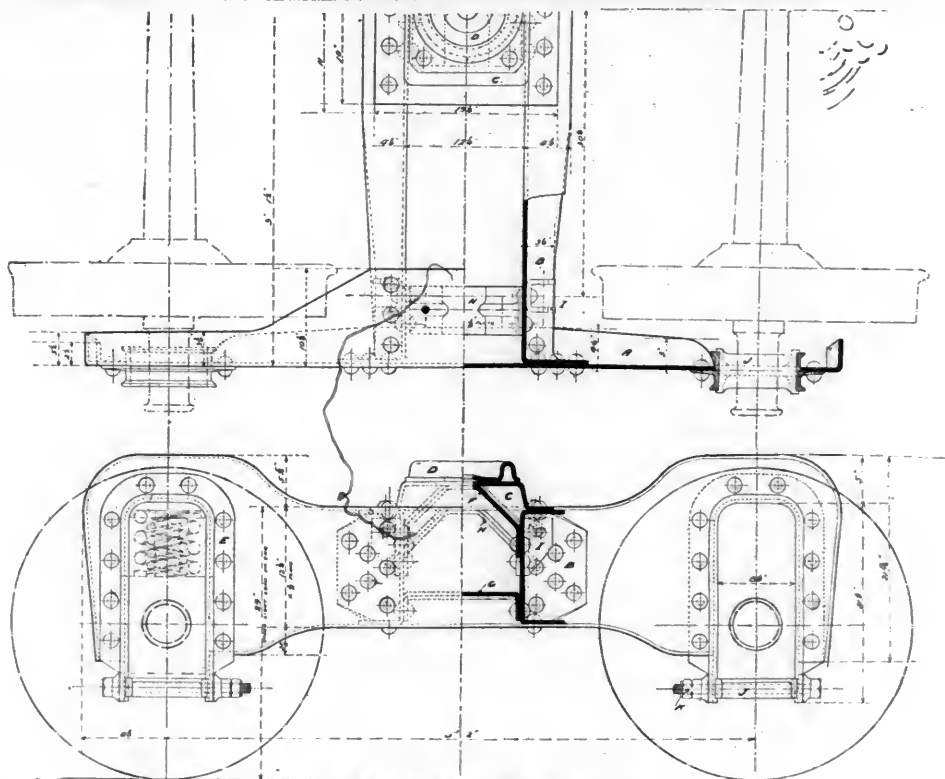


Fig. 54.—Fox Pressed Steel Truck.

members, and with these form the inside legs of the pedestals. In the top of the pedestals are placed the spring caps *EE* and the liners *KK* on the inside of the pedestals form guides for the journal boxes. The pedestal bolts *LL* tie the lower ends of the pedestals together, castings *JJ* forming distance pieces, and washers *RR* being placed under the nuts. At the center the truck sides are tied together by the bolster-channels *GG*, the ends of which are formed into right-angled flanges *TT*, stiffened by the braces *P*, pressed into the plate. The two bolster channels are tied together near their centers by the center braces *HH*, which also form a support for the center-plate. A distance plate *F* brings the center plate to the proper height and distributes the weight over a larger surface. The center plate *II* is made of the usual shape of such plates, made of pressed steel, and the side-bearings, which are shown as castings, are placed directly on the top member of the frame, without any other support. The center braces *HH* are provided at their centers near the bottom with projections *NN*, pressed in, which form a guide for the lower part of the center pin. *MM* are brackets for suspending the brake-beam hangers, when inside hung brakes are used.

BRAKES.

On account of the heavy freight cars of large capacity in use at the present time and the high rate of speed at which freight trains are now run, it is just as necessary, in order to control their speed, to have good brakes on freight cars as it is to have them on passenger trains, and the general adoption of air brakes on freight cars is perhaps only accelerated by a few years by the interstate commerce law, which makes it compulsory to have in every freight train a sufficient number of cars equipped with a brake by means of which the engineer on the locomotive can control the speed of the train independently of brakemen and hand-brakes. This law, together with the acknowledged advantages derived from power-brakes, have brought the air-brake to its present state of perfection, and as a modern car can hardly be

considered as complete unless equipped with such a brake, only this kind of apparatus will be touched upon.

The brake equipment of a car can be divided into two distinct parts, the foundation gear and the air-brake proper, the former consisting of the levers, connections, etc., transmitting the power applied for braking purposes to the wheels, and the latter being that part of the equipment by means of which power is delivered from the locomotive to the foundation gear.

FOUNDATION GEAR.

The most important point in designing the foundation gear is to so proportion the parts as to not prevent the wheels from turning when the power is applied, until the momentum of the car has been stopped, or in railroad parlance to keep the wheels from sliding; theoretically it requires a pressure upon any pair of wheels equal to the weight carried by the wheels to slide them and the maximum effect, with safety, will therefore be obtained if the pressure is so adjusted so as to be somewhat less than the minimum weight on the wheels, which is that of the car without any load divided among the several pairs of wheels. The system of levers is therefore arranged in such a manner that with a certain applied power, the total pressure on the wheels will be about 70 per cent. of the light weight of the car, this ratio having been found to be about right for freight equipment.

The arrangement of levers varies with the details of the car and is usually made so as to equalize the pressure on the different wheels and to always put a tensile strain on the connections. When it is possible, the levers and connections are placed in one horizontal plane, which is that of the center line of the air cylinder, and is generally 7 to 8 inches below the bottom of the sills.

On cars having the usual floor-frame, illustrated in a previous article, with no doors, hoppers or other attachments on the bottom, the arrangement of foundation brake, shown in Fig. 56, is most commonly used. The power of the air cylinder is applied in the direction of the arrow through the push-rod *A* to the

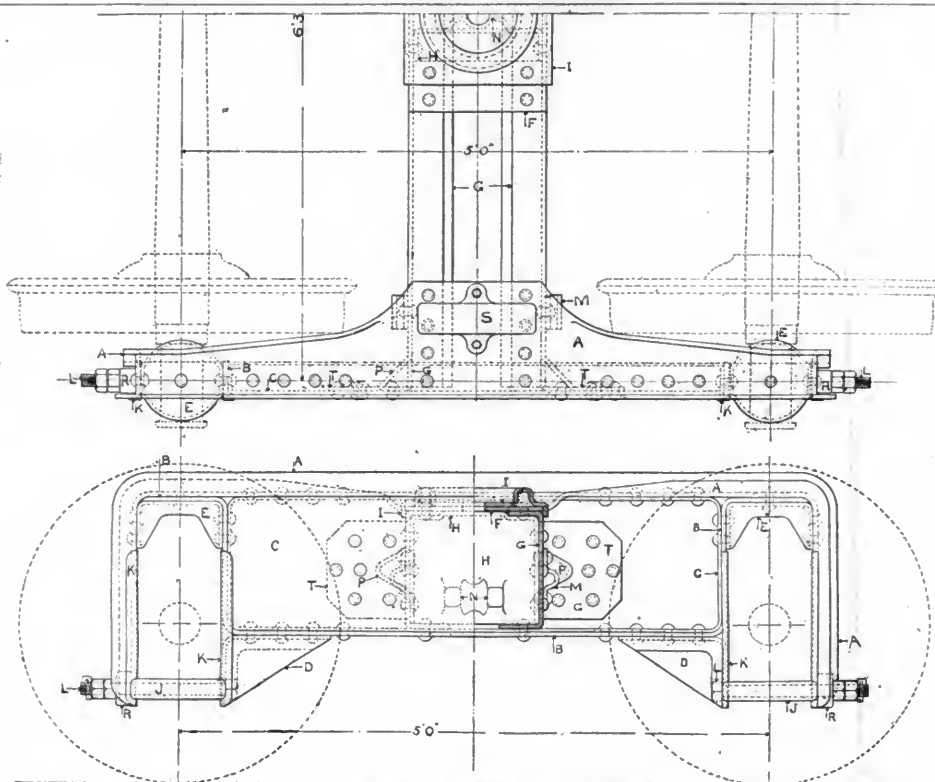


FIG. 55.—Schoen Pressed Steel Truck

cylinder lever *B*, to one end of which is attached the connection *C*, which transmits the power to the truck levers, and through these to the brake beams and shoes. At a certain point on the cylinder lever *A*, between the push-rod and the truck-lever connection, is attached the cylinder-lever connection *D*, which transmits power to the floating lever *E*, and through this to the truck-lever connection *F*, which operates the brakes on the other truck. The cylinder lever *A* is extended beyond the point where the push-rod is connected, and to this end is attached the hand-brake connection *G*, the other end of which terminates in a hook over which the chain *H* is passed, which is wound on the brake-shaft when brakes are applied by hand; when brakes are applied by power, the hand-brake connection is moved in the direction of the brake-shaft, allowing the chain to hang down slack. The ratio between the two ends of the floating lever are generally the same as that of the cylinder lever, the actual lengths being sometimes different to suit local conditions. When a hand-brake is used at only one end of the car, the floating lever is fulcrumed at one end, as shown in full lines, the support being made of flat iron secured to the cross-tie timber and sills of the car. When hand-brakes are used at both ends, the floating lever is extended same as the cylinder lever, and the other hand-brake connection is attached in a similar manner, as shown in dotted lines. Provision has to be made to allow for the floating lever to be fulcrumed at the proper point when the power is applied at the cylinder lever, and also to allow for this point to be moved when power is applied at the floating lever, and this is accomplished by having the floating lever fulcrum *I* made with a slot, in which the pin through the lever is free to move to suit the conditions. The cylinder and floating levers are supported by the lever carriers *J J*, which are usually made of 1-inch round iron, bent in the shape of a U, the ends being flattened and fastened to the sills of the car by lag-screws. An error sometimes made in putting up these carriers is that of having them not long enough, so that the lever strikes the vertical part before the brakes are fully applied.

The proper effect of a force applied to a lever is obtained with any reasonable angles between the levers and their connections, but the lateral or vertical displacement of the connections arising from the motion of levers at extreme angles is so great that they are liable to come in contact with adjacent parts of the car. Furthermore, while the desired ratio between the two arms of a lever are not altered by any reasonable angle which the lever makes with its connections, providing these connections are parallel to each other, the angular position will affect the ratio between the lever arms when these connections are not parallel. It is, therefore, desirable to adjust the brake gear so that when the brakes are applied the levers will be approximately at right angles to their connections. Accurate and symmetrical adjustment of the foundation brakes should be insisted on, as it leads to the cure of many minor defects in the gear.

The operation of this system of brake is as follows: Power being applied to the cylinder lever by the push-rod in the direction of the arrow, this lever will move in the same direction, using as a pivot the point of attachment of that connection which has the most strain upon it, until the tension on the other equals it, when it will move about a point between the two, until the brakes are fully applied, thus always equalizing the strains on the connections.

When the hand-brake at the cylinder-lever end is used, the operation is the same as described, the push-rod moving out with the lever without effect on the piston of the air cylinder. When the hand-brake at the opposite end of the car is used the cylinder lever will move about the point of connection of the push-rod as a pivot, reversing the conditions of cylinder and floating levers.

The arrangement of truck levers and connections varies with the location of the brake beams; if these are hung between the wheels the arrangement shown on the left end of Fig. 56 is used when hung on the outside of the wheels that shown on the right is the proper one. The connections from the cylinder and floating levers are attached to the tops of the live levers *K* and *K'*, a twist in the connection bringing the clevis on the proper angle to

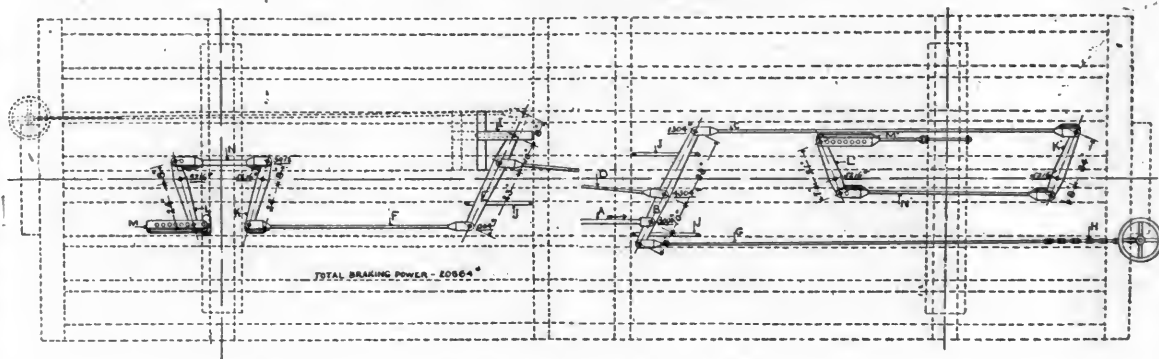


Fig. 56.—Foundation Brake Gear.

take the lever. The top of the dead levers L and L' are held in place by the dead lever fulcrums M and M' , which are fastened in a convenient manner to some part of the truck. These fulcrums are provided with a number of holes, which allow for an adjustment of the brake shoes on the wheels to make up for the wear of the brake shoes and of the connecting pins and holes in levers and connections. The lower ends of the truck levers are connected by the truck connections N and N' , which are usually provided at one or both ends with two holes to allow for a further adjustment on account of wear. When inside-hung brakes are used this connection has a compressive strain on it, and has therefore to be made considerably heavier than the other connections, and many roads are now using a casting of malleable iron for this connection instead of making them of wrought iron. When the construction of the truck will admit the connection between the truck levers is sometimes placed above the brake beam, but this is not a very common construction. On outside-hung brakes the truck connection N' , as shown, is in tension.

For the sake of uniformity the sizes of the principal parts of the foundation brakes, also the general shapes of them, have been adopted as standards by the M. C. B. Association, the most important sizes being 1 inch for the thickness of the levers, $1\frac{1}{4}$ inches for the diameter of all the holes, $1\frac{1}{8}$ inches for the diameter of all connecting pins, and $\frac{1}{2}$ by $2\frac{1}{2}$ -inch iron to be used for the clevises. The connecting rods are usually made $\frac{1}{2}$ inch in diameter, although the bottom truck connections are sometimes made of $\frac{3}{4}$ -inch iron, which perhaps is correct, as the strain on these is considerably more than on the others. When the brake gear is located so that the cylinder connections pass through instead of under the cross-tie timbers, the rod is sometimes cut at the center, and connected by a turnbuckle, so that a large hole need not be cut through the timber to allow the clevis to pass through.

The strains on each connection are shown in Figure 64, being based on a total pressure of 3,000 pounds on the piston, which is about the maximum obtained in an 8-inch cylinder. The figures given are calculated and levers are proportioned for a car weighing about 30,000 pounds, 70 per cent. of which distributed on the four pair of wheels would require a pressure of 5,250 on each brake beam.

The pressure which can be applied by the hand-brakes is usually not as great as that obtained with the air, but hand-brakes are not supposed to be used in coming years, except, perhaps, in switching where the speeds are slow and a light pressure is sufficient for the purpose. When it is desired to increase this pressure and the cylinder lever cannot be lengthened a sufficient amount, a pulley can be attached to the end of this lever, with a chain passing over it, one end being fastened to the brake shaft the other one to some part of the car, such as body bolster or one of the sills, by which means the power due to the length of arm of the cylinder lever would be doubled. The pull on the brake chain is usually 1,000 to 1,200 pounds with the ordinary sizes of brake shaft and hand-wheel in use. The arrangement of foundation

brake shown in Fig. 64 is perhaps the simplest in use. On cars on which there are drop-doors, hoppers or other attachments on the bottom of the frame, it cannot, however, be used in just this shape and usually additional levers must be introduced to get around the obstructions. In some cases a rock-shaft, having levers at each end, is used to transmit power across the car where there is not sufficient space to allow a long lever to swing. Bell cranks can be used for changing the direction of the pull, such as would be necessary where the cylinder has to be placed at right angles to the connections. On cars with long and deep hoppers it is sometimes impossible to place the cylinder on the same level as the brake gear and vertical levers are introduced to transmit the power from one lever to the other.

(To be continued.)

Locomotives Recently Constructed by the Baldwin Locomotive Works.

In the accompanying group of photographs (see next page) we show a number of locomotives of various designs recently built by the Baldwin Locomotive Works, to whom we are indebted for the photographs and descriptions.

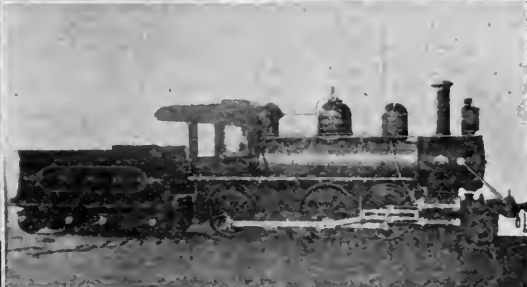
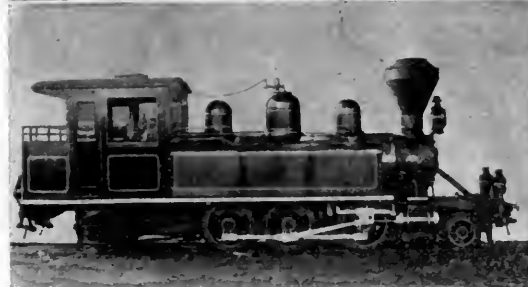
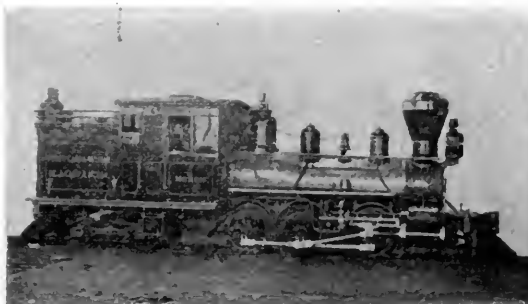
Fig. 1 is the locomotive "Moron," a double-ender, having three pair of coupled wheels and a four-wheeled rear truck, and was built for the Spanish Military Engineers, Havana. Its dimensions are:

Gage	4 feet 8 1/4 inches
Cylinders	12 inches diameter, 18 inches stroke
Driving wheels	38 inches diameter; journals 8 inches by 7 1/4 inches
Total wheelbase	19 feet 5 inches
Driving wheelbase	8 feet, 1 inch
Weight on drivers	45,560 pounds
Weight, total	71,960 pounds
Boiler diameter	36 inches
Tubes	94 in number; 1 1/4 inches diameter; 11 feet long
Firebox	38 1/2 inches long; 35 1/2 inches wide; 46 1/4 inches deep
Truck wheels	24 inches diameter; journals, 3 1/2 inches by 7 inches
Tank	1,600 gallons capacity

The cab of this locomotive is armor-clad, with $\frac{1}{2}$ -inch steel plates on the sides and front, lined with ash. The doors and windows are provided with $\frac{1}{2}$ -inch steel shutters to slide over the glass panes when required, the shutters being provided with loop holes in the center to allow of firing in case of attack.

Fig. 2 is a locomotive, No. 663, of the "Atlantic" type, built for the Lehigh Valley Railroad Company. Its leading dimensions are:

Gage	4 feet 8 1/4 inches
Cylinders	19 inches diameter by 26-inch stroke
Driving wheels	76 inches diameter; journals 8 1/2 inches by 11 inches
Total wheelbase	24 feet
Rigid wheelbase	13 feet
Driving wheelbase	6 feet 7 inches
Weight on drivers	81,800 pounds
Weight on trailing wheels	30,650 pounds
Weight, total	140,950 pounds
Tubes	265 in number, 2 inches diameter, 15 feet 1 inch long
Firebox	114 1/2 inches long, 80 1/2 inches wide, 46 1/2 inches deep
Truck wheels	36 inches diameter; journals 5 1/2 inches by 9 inches
Trailing wheels	55 inches diameter; journals 7 inches by 12 inches
Tender tank	4,000 gallons capacity
Tender wheels	36 inches diameter; journals, 4 1/4 inches by 8 inches



1.—Locomotive for Spanish Military Engineers in Havana.
3.—Double-Ender for a Mexican Railroad.
5.—Double-Ender for a Russian Railroad.

2.—Fast Passenger Locomotive—Lehigh Valley Road.
4.—Compressed Air Mine Locomotive.
6.—Mogul Compound for Norwegian State Railways.

Some Locomotives Recently Built by the Baldwin Locomotive Works.

Fig. 3 is a double-ender locomotive (No. 3), built for F. C. de Casadero a Tepetong, Mex. Its dimensions are:

Gage.....	2 feet
Cylinders.....	11 inches diameter by 16 inches stroke
Driving wheels.....	33 inches diameter; journals, 5 inches by 6 inches
Total wheelbase.....	19 feet 10 inches
Driving wheelbase.....	7 feet 6 inches
Weight on drivers.....	31,910 pounds
Total weight.....	43,410 pounds
Boiler.....	31 inches diameter
Tubes.....	62 in number, 2 inches diameter, 10 feet 11 inches long
Firebox.....	37½ inches long, 30½ inches wide, 40½ inches deep
Two-wheel truck.....	front and back; wheels, 22 inches diameter; journals, 3½ inches by 6 inches
Tank.....	550 gallons capacity, on sides of boiler

Fig. 4 is a compressed air mine locomotive, built for the Ashland Coal and Iron Company. The following are the leading dimensions:

Gage.....	2 feet 7½ inches
Cylinders.....	9 inches diameter by 14 inches stroke
Driving wheels.....	33 inches diameter; journals, 4 inches by 6 inches
Total wheelbase.....	5 feet 3 inches
Driving wheelbase.....	5 feet 3 inches
Weight on drivers.....	20,550 pounds
Weight total.....	20,550 pounds
Air reservoirs.....	one 20½ inches diameter, 18 feet 5 inches long; one 20½ inches diameter, 15 feet 9 inches long; one 13¾ inches diameter, 13 feet 1¾ inches long

The locomotive is fitted with an auxiliary reservoir and a reducing valve. The main reservoirs carry a working pressure of 600 pounds per square inch. The limit of height is 5 feet, width 6 feet and length 19 feet.

Fig. 5 is a double-ender locomotive built for the Krotovka-Sergievsk line in Russia. Its dimensions are:

Gage of road.....	3 feet 3½ inches
Cylinders.....	10 inch diameter, 16 inches stroke
Driving wheels.....	36½ inch diameter; journals, 4½ inches by 6 inches
Total wheelbase.....	19 feet 9 inches
Driving wheelbase.....	7 feet 6 inches
Weight, total.....	37,160 pounds
Weight on drivers.....	33,010 pounds
Boiler.....	31 inches diameter
Tubes.....	70 in number, 1¾ inches diameter, 10 feet 1 inch long
Firebox.....	45½ inches long, 21¼ inches wide, 45 inches deep
Truck wheels.....	24¼ inches diameter; journals 3¼ inches by 6 inches
Tank capacity.....	600 gallons (carried on sides of boiler)

Fig. 6 is a Mogul compound locomotive, built for the Norwegian State Railways. Its dimensions are:

Gage of road.....	3 feet 6 inches.
Cylinders.....	high pressure, 9 inches diameter by 19 inches stroke
Driving wheels.....	low 15 18 18 inches diameter
Journals.....	5½ inches by 7 inches
Total wheelbase.....	18 feet 7 inches
Driving wheelbase.....	12 feet 0 inches
Weight, total.....	51,211 pounds
Weight on drivers.....	42,214 pounds
Boiler, diameter.....	44 inches
Tubes.....	157 in number, 1¾ inches diameter, 8 feet 1 inch long
Firebox.....	52½ inches long, 30½ inches wide, 40½ inches deep
Truck wheels.....	26 inches diameter; journals, 1 inches by 6 inches
Tender, tank capacity.....	1,400 gallons
Wheels.....	26 inches diameter; journals, 3¼ inches by 6 inches

The above engine was the 15,000th locomotive built by the Baldwin Locomotive Works.

Citizenship and Technical Education.*

BY JOHN H. CONVERSE, A. B.

The debt which the citizen owes to the community for higher education involves an obligation on the part of the recipient which cannot in most cases be discharged by a pecuniary consideration. You who are alumni, or are to be alumni, of an institution like this are not privileged to use your intellectual equipment here acquired solely for your own aggrandizement. Society has claims upon you. In the practice of your profession you must contribute something to the welfare of the community as opportunity offers. The clergyman performs many offices of mercy for those in need, but who have no claim upon him. The physician, in his hospital practice and in his gratuitous attendance on the poor, renders an extensive service for which he receives no monied compensation. The lawyer, by his conduct of the cases of those unable to engage counsel discharges in some measure the obligation under which he rests. Are these learned professions, as they are called, alone amenable to this rule? There are emergencies and conditions where the mechanic, the engineer, the architect, the chemist, may render a valuable service to the community, and which he should regard as opportunities of privilege. You may not ask the architect to draw plans for your house without full compensation, but for an art gallery, or a hospital, or a library, for the benefit of society, you might well expect a concession in the regular fee. It is agreed that the happiest definition of civil engineering is that it "is the art of directing the great sources of power in nature for the use and convenience of man." If the engineer (and in that term we may include all the graduates of an institution like this) possesses a power so important, built up, as it has been, by the experience of thousands of predecessors, and made possible of acquisition by the founding of technical schools like this, he certainly has a duty to use it in some measure for the benefit of his fellows. Christianity teaches us that the Saviour of mankind promises the highest recognition of service done in His name to even the least of those in need. The relations of men in society show that there is an obligation of service even in the realm of materialistic progress.

The foregoing considerations lead to the inquiry, What scheme of education is best adapted to promote true citizenship? The true citizen must be more than a narrow specialist. His education must be thorough, comprehensive, humanizing, practical. The function of the university, properly so called, is to afford precisely such a training. It should include not only the humanities, but also, necessarily and inseparably, the preparation for a profession or calling.

The ideal university then might have, first, say, a three years' course in the humanities, leading as now to the degree of A. B.; and, secondly, a two years' course in technical, scientific, legal or other specific studies leading to the degree of C. E., M. E., E. of M., or other appropriate degree. And these two courses should be made, not optional, but obligatory, forming in effect a five years' course. If it be said that students will select in preference a merely technical school where in a shorter time the desired diploma may be obtained, I answer that I have no concern with that policy. My contention is that there is room for a university wherein the training afforded and enforced shall make the citizen as well as the engineer, the broadly-cultured, self-reliant man, and not a specialist exclusively.

The trend of educational development points, I think, to something of this character as the true university. A marked change has come over the schemes of higher education during the past generation. Formerly the theory in our universities was culture for culture's sake. Utility, as an essential of the studies pursued, was little regarded, or was scouted as something common or unclean. The classics, the mathematics and metaphysics constituted in the main the approved curriculum. Complete courses in chemistry, in biology and physics were rare in the department of arts. Even the modern languages scarcely ever appeared in the curriculum. The classics were emphasized to the exclusion of the natural sciences. Some in my hearing may remember the sensation produced by Charles Francis Adams, when two or three decades ago, in an oration delivered before the Phi Beta Kappa Society of Harvard, he denounced as a fetich the slavish worship of Latin and Greek in the college course. The feeling which he then voiced has unceasingly prevailed. Since that time the change in college methods has been remarkable. Requirements in entrance examinations have been enlarged. More Latin and Greek, and mathe-

matics and English literature, and history are demanded as a condition of matriculation in order that more time in the four years' course may be available for the natural sciences, literature and the modern languages. In many colleges scientific courses and elective special studies struggle to replace the time-honored curriculum. Laboratory work has been introduced and enlarged; geology and biology are pursued by practical investigation; and even manual training and shop practice have found a place as cognate branches in some of our universities.

The significance of this movement is not far to seek. At a time when the ruling interests of the country were agriculture and the products of the forest and the sea, a college curriculum molded in mediæval form was sufficient. But with the development of mines and manufactures of every kind and the extension of new conditions of life, a different training was demanded. Our educational institutions have responded under the pressure of a new civilization. The founding of this institution 30 years ago was but the recognition in the mind of a sagacious business man of the demands of a new era of materialistic development. The shaping of its scope and purpose is an indication of the best form which is to be reached by what we call higher education.

In order that the general course may be covered in the term of three years, the time usually given to Greek and Latin might be considerably curtailed. In proposing such abridgement I am not insensible of the value of the study of the classics, but for the ordinary student without especial taste for the dead languages and their literature, I believe that much of the time ordinarily devoted to their study might more profitably be bestowed on other subjects. For all etymological and technical uses, one-half the time usually given to Greek and Latin in the curriculum would suffice.

It is undeniable that many boys enter college with no well-defined purpose as to their future. Neither they nor their parents know for what calling they are best adapted. A three years' general course, while giving them a broad and comprehensive culture, would better enable them to judge what profession or calling to adopt, and would bring them to an age of superior discretion, when their choice could more intelligently be made. The example and the influence of the engineering or special courses, of which by contact and contiguity they gain some knowledge, would greatly facilitate such choice. During the three years' general course the student would have constantly before him the suggestion and the purpose of acquiring a technical training, and would be less likely to be satisfied with the degree of A. B. alone.

Another advantage of the scheme, incidental, but most desirable, in my judgment, would be the opportunity for practical work which might be interjected between the general and the technical courses. At the end of the three years' general course let the student spend a year in actual business or work. Employment in the line of his future profession would be preferable, but failing that, any business experience would be beneficial. To illustrate this, take the case of an intending mechanical engineer. At the end of the three years' course the university might give and encourage a year's leave of absence, during which period the young man might find employment in a machine shop or factory and obtain some practical training in the use of tools and machinery. Much could be accomplished even in that brief time, and I venture to assert that there are many manufacturers in the United States who would heartily co-operate in such a scheme. The young man, after a year or 15 months of practical work, would enter upon the scientific studies in mechanical engineering with a higher appreciation of their value, with a more intelligent comprehension of their application, and with greater ability to assimilate the theoretical principles of the text-books. It is a well known fact that the best draughtsmen (and I use the term not for mere copyists, but for designers) are those who have had shop practice. They have learned what tools can do, and by what process results can be reached most economically and effectively. I need not extend the illustration. You will at once apply it to the case of the civil engineer, the engineer of mines, the chemist, and the architect.

The young man who has thus taken the complete course of five or six years will, when he finally receives his engineering degree, be entitled to stand as a thoroughly educated engineer. His culture will have been broad and liberal. He will be equipped for the highest citizenship, and he can stand as a peer of any in the community. There are few professions where the widest knowledge can more fully be utilized than in that of the engineer. No man, whatever his calling, can know too much. He will find use in the most unexpected manner for attainments apparently foreign to his pursuits. The engineer, of all men,

* From an address delivered to the students of Lehigh University on Founder's Day, Oct. 8, 1898.

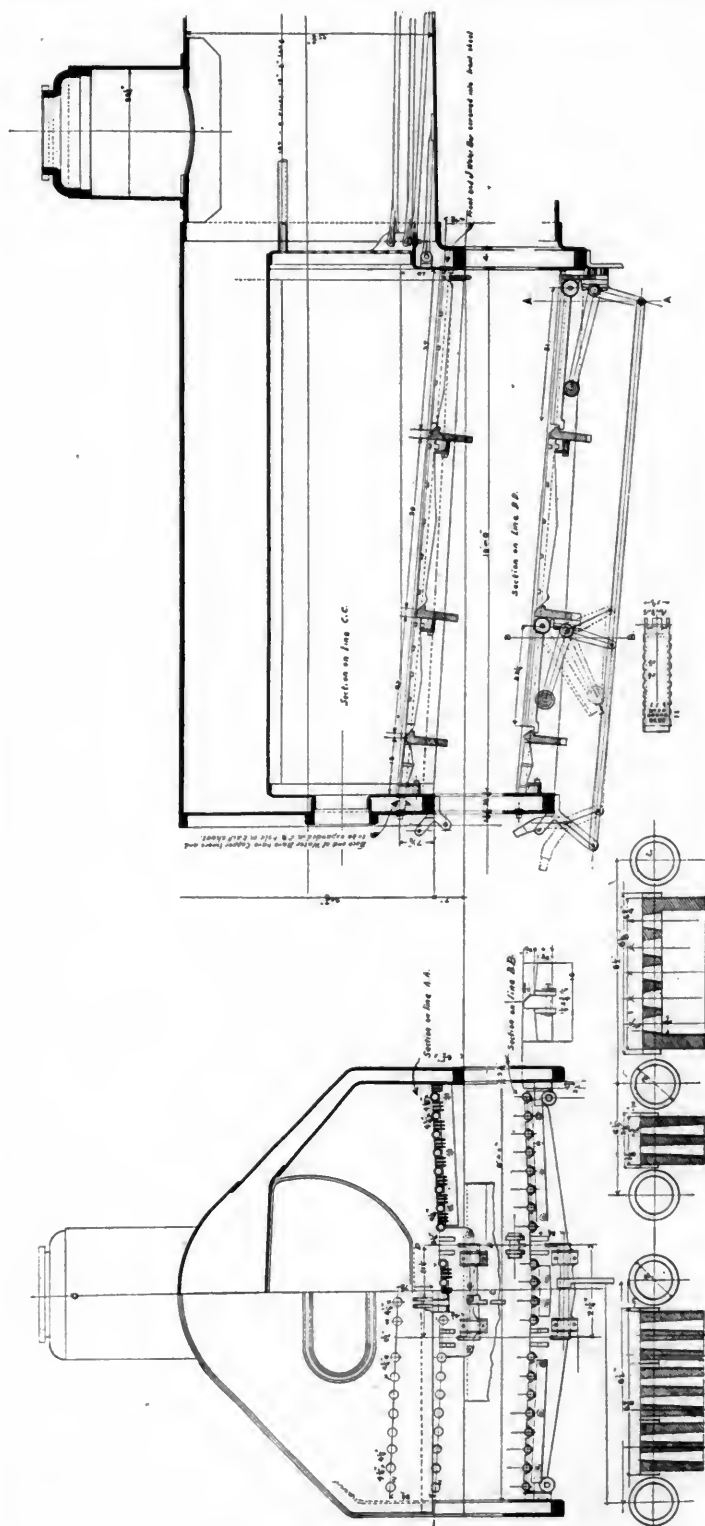


Fig. 1.—Grate for Burning Fine Anthracite Coal—Delaware, Lackawanna & Western Railroad.

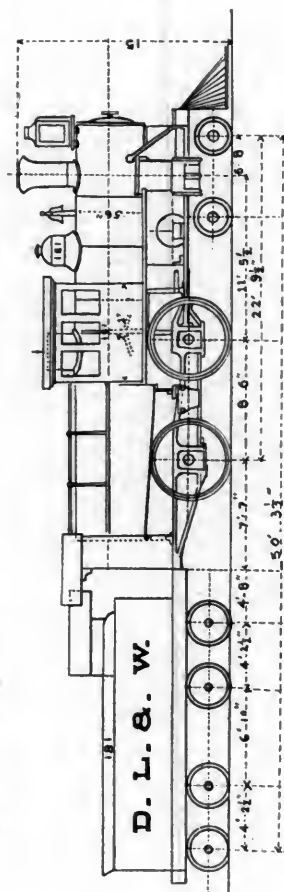


Fig. 2.—Locomotive Altered to Burn Fine Anthracite Coal.

Cylinders.....	19 1/4 inches by 24 inches
" steam ports.....	1 1/4 inches by 17 1/4 inches
" exhaust.....	3 inches by 17 1/4 inches
" bridges.....	1 1/4 inches
Slide valves.....	Allen-Richardson balanced
" travel.....	.5 inches
" outside lap.....	.7 1/2 inches
" inside.....	line and line
Boiler, diameter of front course, inside.....	.56 inches
Flues.....	215, 2 inches diameter, 12 feet 10 inches long
" heating surface.....	1,844 square feet
Boiler, center to rail.....	8 feet 5 inches
Firebox.....	8 feet wide, 10 feet long
" grate area.....	.80 square feet
" heating surface.....	140 square feet
Total heating surface of boiler.....	1,981 square feet
Weight of engine on drivers (loaded).....	84,400 pounds
" " truck.....	34,100 pounds
" " coal.....	118,500 pounds
" " oil.....	5,700 pounds
" coal.....	7 tons
Boiler pressure.....	161 pounds per square inch

The Explosive Properties of Acetylene.

Some experiments recently completed by Messrs. Berthelot and Vieille show that considerable precautions are necessary in dealing with acetylene, particularly in the compressed state. The gas in question is an endothermic body, that is to say, a quantity of heat is liberated on decomposing it into its constituents, hydrogen and carbon. Reasoning on this basis, the experimenters determined to try whether the gas could not be detonated by means of a cap of fulminate of mercury. This proved possible, though at atmospheric pressures the explosive wave did not proceed throughout the body of the gas, the decomposition being limited to the immediate neighborhood of the detonation. When, however, the gas was compressed, the experiments showed that it might prove a dangerous explosive. In fact, it was not then necessary to use a detonator, as it was found that the mere heating of the gas by an incandescent platinum wire was sufficient to cause an explosive decomposition of the acetylene. Average figures from a number of experiments made with different degrees of initial compression showed the following rises of pressure:

Initial pressure. Pounds per square inch.	Maximum Pressure observed on ex- plosion. Pounds per square inch.	Ratio.
31.7	138.7	4.4
49.4	271.0	5.5
85.1	694.0	7.0
110.0	1,312.0	8.2
110.0	3,025.0	10.1

On opening the steel test tube after an experiment, it was found to be filled with a mass of finely divided carbon agglomerated together by the increase of pressure. The rise of temperature at the moment of explosion was considerable, and in the case of the last of the experiments, referred to above, amounted to as much as 2,750 degrees centigrade. It was, moreover, found possible to detonate liquefied acetylene in the same way, a pressure of over 35 tons per square inch being then attained. The explosion was started, as in the previous cases, by means of a white-hot platinum wire. Dropping a bottle of the liquefied gas, or allowing a heavy tup to fall on it, proved insufficient to detonate the mixture, although when the bottle was broken by the tup a violent explosion occurred. This, however, arose from the combustion of the gas, and thus differed materially in nature from the experiments previously made, in which the acetylene was merely resolved into its elements.—*Engineering*.

Corrosion of Metal Tender Frames.

In a discussion on the preservation of metal frames for tenders and cars, before the Western Railway Club, Mr. E. M. Herr said in part:

"On the Chicago & Northwestern road we have a large number of all metal underframes on tenders which have now been in service from eight to twenty years. In general the service of these underframes has been good up to this time, and they have given but little trouble. These metal frames are now rusting away, and though none have yet corroded so much as to require renewal, the last few years' experience indicates that the amount of corrosion is increasing in an advancing ratio which will soon make extensive repairs necessary, if, indeed, entire renewal does not have to take place. This corrosion is not uniform. Those in service a long time are often not more corroded than those in service not so long. This is no doubt due to a different kind of usage and difference in the kinds of water, as, indeed, the leakage from the tank has a great deal to do with the corrosion. The following table gives the principal data in regard to these sills:

Kind of Engine.	Cylinders.	Year built.	Cap. of tank.	Max. Corrosion on iron sills.	Min. Corrosion on iron sills.	Aver. Corrosion on iron sills.
				Per cent.	Per cent.	Per cent.
8-wh. road.....	16x24	1879	2,350	10.7	4.5	7.0
" " ".....	16x24	1880	2,000	15.0	1.5	8.3
" " ".....	16x24	1883	3,000	11.2	5.7	7.8
6-wh. aw'cht.....	17x24	1888	2,300	11.2	6.7	9.0

"I will sum it up in saying that the maximum amount of corrosion found in the sills of these tenders which have been in service two of them 16 or 17 years, the other two 8 or 9 years, amounts to from 10.7 to 15 per cent. per section. The minimum amount of corrosion varies from 1½ to 6½ per cent., the average being from 7 to 9 per cent. This shows that the tender frames 8 and 9 years old are rusted worse in some cases than those 16 and 17 years in service."

Mr. Herr then referred to the investigation on the Eastern Railway of France, published in the August number of this journal, in which one conclusion arrived at was the desirability of painting metal frames once in three years, and states that his road has decided to treat their tender frames in the same way. He thought the paint could be sprayed on by compressed air.

Electricity as Applied to Traction.

At the opening meeting of the twenty-third session of the Liverpool Engineering Society, the President-elect, Mr. S. B. Cottrell, delivered, before a full audience of members and their friends, his inaugural address.

He said he proposed to follow what had usually been the custom on these occasions, viz., to deal with the particular aspect of engineering with which he was himself directly interested—the development of railways. The President referred, in the first place, to the rapid expansion of railway enterprise, pointing out that while not more than 67 years had elapsed since the completion of the Liverpool & Manchester Railway, there were now open in various parts of the world upward of 400,000 miles of railway. He showed that as soon as steam power was applied to manufactures in this country railways became a necessity. Their introduction developed our coalfields, and their expansion in various parts of the world had greatly increased employment for shipping and stimulated steam navigation. After sketching the general expansion of railways, Mr. Cottrell came to the main point of his address—Electricity as applied to traction. The first great step forward in this direction was made in 1867, when Dr. Werner Siemens described to the Berlin Academy his discovery of a self-exciting dynamo, a discovery soon followed by the transmission of power from one dynamo to another. Electro-motive power, however, began in earnest with the opening of the first electric railway in Berlin in 1879. The subsequent growth of electric rails and tramways in this country, on the Continent, and in the United States and Canada, where 90 per cent. of the street railways are worked by electro-motive power, was the subject of an interesting reference. In this direction he pointed out the special value of electric traction for the purpose of inter-communication in cities, mentioning the particular instance of London, whose worst deficiencies in this respect were about to be remedied by new underground electric railways now authorized or in course of construction. By the application of electricity, the notorious discomforts of the London Underground would doubtless before long become a mere record. Discussing the application of electricity to main lines of railway, Mr. Cottrell was of opinion that the application would mean a different class of electric traction to that now employed. The present system of 500 volts continuous current had to be limited to a distance within 12 miles with any degree of economy, but by doubling the present working voltage the cost of transmission would be enormously lightened. A 1,000 volt current would not be impracticable under proper conditions as to safety. It would reduce the cost of conductors to one-fourth the present amount, and the problem would be enormously simplified by operating roads 30 or 40 miles in length from a single power station, while these stations, if placed where coal and water were abundant and worked by latest labor-saving appliances, would reduce the cost of output to a minimum, and enable power to be economically transmitted at high voltage to transferring substations on branch lines up to 150 miles away. If the suggested speed of 100 to 120 miles an hour was ever to be attained, it would be by the electric locomotive. There was practically no limit to the rotary motion of an electric motor, while, unlike the steam locomotive where the speed was increased by increasing the size of the driving wheels, and thus reducing the tractive power, the wheels might be of small diameter, which reduced the wheel base and gave the highest efficiency of tractive power. The Heilmann locomotive made a great stride in advancing electric traction, since it did not involve the use of power stations. This locomotive generated its own electricity, which was conveyed to motors fixed on the wheels. The whole weight of the locomotive was utilized for tractive purposes, and was unlike the steam locomotive in this respect, since in the latter only a small part of the weight was so made use of. Another advance was Tesla's discovery of the rotating magnetic field and the construction of a motor which dispensed with commutators and brushes, always a source of trouble and expense. These improvements pointed to others, and showed that the record of railway development, one of the most interesting chapters of practical science, was far from closed.

New Publications.

ONE THOUSAND POINTERS FOR MACHINISTS AND ENGINEERS. By Chas. McShane. Griffin & Winters, Chicago. 326 pp., 5½ inches by 7½ inches.

This is a second edition of a book of the "practical" type, and intended for engineers, firemen and mechanics. There is one fact which has always been puzzling. Why is it that authors of this kind of literature seem to think that the omission of definite and indefinite articles, and other minor words, makes what they write appear more practical? As an example the directions which are given for lining up guides may be taken. These are represented in the following extract, with the omitted words in italics and parentheses.

"Measure *(the)* distance from *(the)* top of *(the)* cross-head to *(the)* center of *(the)* cross-head. Line *(the)* cylinder. Set *(the)* top guide first *(at the)* right distance from *(the)* line, use a square on *(the)* side and keep *(it)* perfectly central with *(the)* line and level with *(the)* frames. Caliper *(the)* head and set *(the)* bottom guides *(at the)* right distance from *(the)* top guide and perfectly central with *(the)* top guide. Slip in your gib and line *(it)* up close, then put up *(the)* head."

The whole book is written in this kind of railroad English, apparently with the idea that it gives to the language a sort of air of practicality. To paraphrase the language attributed to Mr. Lincoln, "If practical men like this sort of writing, then this is the kind of book which will suit them." The fact is, though, that the omission of the minor words often makes the writing indefinite, as for example when the author says, "use a square on side and keep perfectly central." It is not apparent what is to be kept central. We have inserted the word "it" on the assumption that he means the *s*. *r* should be kept central, but that is not certain.

The purpose of the book, the author says, is to give instruction in the "modern methods of performing work in the various branches of our trade, locomotive construction being the special feature." The discussion of the various subjects treated is a kind of combined explanation of the construction, operation, erection and repair of the different parts of locomotives. While these contain a great many very useful directions and hints to practical men, the general defect of the treatment of the subject is that they lack comprehensiveness. But, it may seem to be invidious to find fault with a plate of very excellent hash by saying that it does not include soup, fish, a roast, an entree and a dessert. Good hash is excellent and very nourishing food, and has great capacity for "staying by you." Now, metaphorically, the book before us has all these characteristics. It is full of useful information and mental nourishment, and any practical or theoretical person who will study it will find that the information it contains will "stay by him" as long as life lasts.

It begins with a brief history of the locomotive and treats of the following subjects: Slide valves, link motion, steam indicators, locomotive-testing plant, cylinders, wheels and axles, shoes and wedges, rods and brasses, guides, cross-heads, etc., steam chests, pistons, rods, packings, etc., exhaust nozzles, steam pipes, etc., lathe work, metric system, injectors and checks, lubricators, steam and air gages, compressed air, locating blows and pounds, breakdowns, accidents with compound engines, Lewis valve gear, modern locomotives, fast runs, air-brake and improved tools.

The discussions of those subjects are more of the nature of practical directions how to do what requires to be done than of theoretical elucidation of them. The section relating to counterbalancing may be taken as an illustration. In explanation of the theory of it it is said:

"Reason will teach you that there is no such thing as having an engine counterbalanced perfectly at all times, for the simple reason that steam is the power, and if balanced perfectly when using steam it will not be perfect when the steam is shut off, as the steam carries the piston-head, cross-head, etc. The object is to balance the wheels as near as possible, when running, and overcome a part of the strain in the pin when shut off. But to counterbalance the parts approximately correct, so that excessive strain will not be imposed, is quite possible; care must be exercised to avoid too heavy a counterbalance, as it would give an excessive rail pressure."

Now, it would require a somewhat full dissertation in the subject of counterbalancing to show the inadequacy of the explanation of the theory, and for this there is not time now nor room here. After the explanation quoted full and specific directions are given—excepting that most of the definite articles are omitted—for arranging, proportioning and putting the counterbalances in the wheels of a locomotive. Most of the other subjects are treated in a similar way. The practical shop man will find the instructions are usually very clear, and that they will be very useful. A good index adds to the merits of the book.

A MANUAL OF STEAM BOILERS, THEIR DESIGN, CONSTRUCTION AND OPERATION. By R. H. Thurston, Dr. Eng'g, Director of Sibley College, Cornell University. New York: John Wiley & Sons. 881 pp., 5½ inches by 9½ inches.

There are books which are calculated to produce a feeling of dismay in the mind of a reviewer when he takes them up to summar-

ize their contents and estimate their merits in the few paragraphs which can usually be devoted to them in a notice of this kind. The book before us is one of this kind. Its size, the wide range of subjects treated, the distinguished reputation of the author and the extended field of his experience and knowledge, from which he has been able to garner its contents, incline a reviewer to hold his opinion in abeyance rather than to express it with much confidence. A review of such a book in the time and space which is available must of necessity have very much of an "impressionist" character and cannot be an adequate analysis of its contents, and mere enumeration of the heads of the chapters will indicate how impossible it would be to say more in a notice of this kind than merely to express an opinion of the scope and purpose of the book. The general subjects of the different chapters are as follows: History; Materials; Fuels and Combustion; Heat; Thermodynamics; Steam; Design; Accessories—setting and chimneys; Construction; Specifications; Operation and Care; Efficiencies; Trials; Explosions; Appendix.

The first observation which is suggested is that the book is too big. In these busy times, how many engineers can be found who have the time to wade through nearly 900 pages unless they contain matter of pre-eminent importance. Instead of this being so in the present instance, in many places the writing seems to be unnecessarily prolix. Take as an example the following paragraph:

"Safety in operation is one of the most essential requirements which the designer, constructor and user of steam boilers must be prepared to fulfill. As will be seen later, the quantity of stored heat-energy in the steam boiler is usually enormous, and this energy is stored under such conditions that, if set free by the rupture of the containing vessel widespread disaster may ensue."

It is said in the preface that the book is intended for engineers and a text-book in schools of engineering. Can it be possible that there are any persons in either of these two classes who will read such observations with either profit or interest? Would it occur to anyone worthy of being called an engineer or a student in a school of engineering to think that "safety in operation" was not "one of the most essential requirements" in boiler construction? Can it be that any person in either of those two classes is ignorant of the fact that "the quantity of stored heat-energy in the steam-boiler is usually enormous," or that it "is stored under such conditions that if set free by the rupture of the containing vessel, widespread disaster may ensue"? Or again, the chapter on Materials opens with the observation that "the quality of the materials used in the construction of steam-boilers must obviously be very carefully considered" (who thinks otherwise?) "Not only is the steam-boiler expected to bear great strains and high pressure, but the terrible consequences which are liable to follow its rupture makes it important that it should sustain its load and do its work with the most absolute safety." Who doubts it? What is the use of loading down what is intended to be "a fairly complete, systematic and scientific, yet 'practical' manual on the steam boiler, its design, construction and operation," with such commonplace remarks?

Or take still another illustration. On page 42 it is said: "Problems in steam-boiler design and construction are among the most interesting, as well as important, which arise in the practice of the engineer. These problems may and usually do take many distinct forms." Or, again, the reader is told that "the general method of solution of problems in design is to study the case very carefully in the light of all information that can be gained relating to the special conditions affecting it, and then by comparison of the results of experience with various boilers under as nearly as may be similar conditions determining the best form for the case in hand." All this is very, very obvious. Why should a book intended for full-grown engineers be loaded down with such trite observations?

Some fault may also be justly found with many of the engravings. Most of them are "process" reproductions from other engravings for which no credit is given. Some of these on pages 24, 25, 30, 32, 34, 36, 40, 148, 378, 379, 392, 396, 406 and 419 are wretchedly bad. The author and the publisher of the book would both consider it very "bad form" to appear in public with a soiled collar or shirt-bosom, but they have issued this publication with engravings which are smudged to an extent which makes them not only unsightly but incomprehensible. A collar is worn only for a day or an evening, but the illustrations of a book like this are to be presented to the public through a whole life-time or longer, and are intended to serve a much more important purpose than any merely personal habiliments ever do.

In announcing that his book "is the outcome of an attempt to meet a demand for a fairly complete, systematic and scientific, yet 'practical' manual," an author assumes the responsibility of his own reputation. In the present instance such an announcement may fairly lead the reader to expect that such an attempt would

result in a treatise which would somewhat comprehensively summarize the most important existing knowledge relating to the subject, or, in other words, that it would give a fair presentation of the "state of the art" of boiler-making up to date. Judged by this standard the book is disappointing, and is not what the reputation of its distinguished author would lead the reader to expect. The chapters on the design and construction are neither "complete, systematic, scientific," nor "practical," and, considering their importance, the treatment of these subjects is entirely inadequate for a treatise such as the one before us purports to be.

The best chapter, perhaps, is that on boiler trials, and even in that the reader must feel inclined to resent being told that in making such trials "the engineer conducting the experiments is expected to ascertain all the facts which go to determine the performance of the boiler, and to state them with accuracy, conciseness and completeness. In the attempt to ascertain these facts the engineer meets with some difficulties, and finds it necessary to exercise the utmost care and skill." Really! Some of the illustrations of the chapter on boiler explosions would be unworthy of an illustrated Sunday sensational daily or "penny dreadful." What is valuable in the book could be condensed into a half or a third of the space, and in that form would be much more useful than it now is. Those who know the admirable work which Professor Thurston is capable of and has done must feel that he has hardly done himself—or his readers—justice in the book before us.

Books Received.

CATALOGUE OF THE MICHIGAN MINING SCHOOL, WITH STATEMENTS CONCERNING THE INSTITUTION AND ITS COURSES OF INSTRUCTION FOR 1896-1898. Houghton, Mich. 1898.

CATALOGUE OF THE UNIVERSITY OF ILLINOIS, 1895-96. Urbana, Ill.

COMMISSIONER'S REPORT ON THE QUEENSLAND RAILWAYS FOR THE YEAR ENDING JUNE 30, 1896. Brisbane, Queensland, Australia, 1896. 66 pages. 8 inches by 13 inches.

TENTH ANNUAL REPORT OF THE COMMISSIONER OF LABOR. Volume II., 1894. Strikes and Lockouts. Government Printing Office, Washington, D. C.

SPECIAL CONSULAR REPORTS. Money and Prices in Foreign Countries, being a series of reports upon the currency systems of various nations in their relation to prices of commodities and wages of labor. Volume XIII., Part I. Bureau of Statistics, Department of State, Washington, D. C. 1896.

Cost of Repairs to Electric Street Cars.

In an article on "Car Trains vs. Double-Truck Cars," the *Street Railway Journal* makes a comparison between the repair expenses of short and long street cars. The long cars are mounted on two four-wheeled trucks, and have bodies 28 feet long with 18 cross-seats, giving a seating capacity of 30 in summer and 34 in winter, when the stores are in use. The cars weigh 23,500 pounds each, and there are 44 of them in the service from which the data is collected.

The short cars are only 20 feet long over the body, are carried on four wheels and weigh 16,000 pounds. They seat 28 persons in summer and 27 in winter. They haul trailers when traffic is heavy, and these trailers weigh 5,000 pounds, and seat from 19 to 35 persons.

The cost of repairs to these cars are given in the accompanying table. The motors for the long cars are G. E. 800 and for the short cars W. P. 50.

	No. of cars	Average seats per train	Motor repairs.				Truck repairs.				Total motor and truck repairs per car per day.
			Total for first six months of 1896.	Per car per year.	Per seat per year.	Per car per day.	Total for first six months of 1896.	Per car per year.	Per seat per year.	Per car per day.	
Long car.	44	35	\$6,681.43	\$303.70	\$8.66	\$0.83	\$5,328.58	\$242.21	\$4.93	\$0.66	\$1.49
Short car.	74	35	7,304.04	189.74	5.42	0.52	4,274.59	111.02	3.18	0.30	0.82

From this table it will be seen that the total repairs to a long car per year is \$545.91, and for the short car the figures are \$300.76. For a comparison it would be necessary to go into many other items besides repairs (and this has been done in the article referred to), but to our readers the interesting point is that the expense for repairs should be as great as they are shown to be in the table we have copied.

Trials of the Pneumatic Machinery on the U. S. Monitor "Terror."

The monitor *Terror*, of the United States Navy, is a vessel that has attracted considerable attention from naval experts because of the pneumatic machinery installed on board of her. Compressed air is used to operate the gun turrets, elevate and depress the guns, hoist the ammunition, take the recoil of the guns and to steer the ship. About the middle of last month the vessel left her anchorage off Staten Island and steamed out to sea to give her guns and the pneumatic apparatus a full trial. From the account of the first day's trial, as it appeared in the *New York Sun* of Nov. 20, we take the following:

The monitor *Terror*, of the United States navy, did to-day what no other ship in the United States navy ever did. She fired solid shot at sea from her four 10-inch guns in one volley. All the guns went off as one piece. They were fired by electricity from the bridge. Nearly 1,000 pounds of powder was burned in doing it and a ton of metal was hurled into the deep. That volley represented about \$500 worth of material destroyed. The recoil of the four guns represented no less than 55,000 foot-tons, and yet the *Terror* showed scarcely a tremor as the guns plunged back from the discharge and then slid into their places.

Eight years ago Secretary Whitney of the Navy Department signed a contract with the Pneumatic Gun Carriage and Power Company, of Washington, to supply a pneumatic system of steering and of operating the machinery turrets in the *Terror*. No vessel in the world had ever made use of a pneumatic system in steering or in operating turrets, and Secretary Whitney's contract was a good deal of an experiment. It was not until yesterday and to-day that any test was made of the system. The *Terror* is still the only vessel in the world so equipped, and upon the result of this test may depend important changes in handling big guns on warships and in steering all kinds of large vessels. The trial was not fully completed, but so far as it went it was a complete success for the pneumatic system.

It is because of the fact that the *Terror* may mark another distinct advance in naval affairs by Americans that this trial trip was of unusual significance. On April 15 last the vessel went into commission. She went out cruising for two weeks in August and it was found that, so far as steering went, the pneumatic system, whether operated directly by wheels or by levers under electric control, was successful. It was also found that in turning the turrets, elevating or depressing the guns, hoisting the ammunition, loading the guns and receiving the terrific recoil after their discharge, the system was effective and superior to the use of steam or hydraulic power. The air-compressors (made by the Norwalk Iron Works Company) get up a working pressure in from two to three seconds. There is no reservoir for the compressed air except the large 8-inch pipe which runs through the ship. In this pipe a pressure of 125 pounds to the square inch is generated in 45 seconds. A small pipe leads some of this air to the steering-room. It passes into cylinders on either side of the rudderhead. A man turns a wheel in the chart-room, turret or steering room with a pressure of one finger and from one of these cylinders a big piston rod emerges and pushes the rudderhead as far as the man at the wheel desires. There is no rattle of chains, no leakage of pipes, no overheated room. When the man at the wheel wishes to throw the rudder the other way the piston from the other side darts out and the rudder goes over. A small lever can be attached to an electric motor (controlling the air-valves) and by swinging this lever back and forth the rudder goes over as easily as if a massive steam engine had done it all.

This rudder was turned to-day from hard-a-port to hard-a-starboard in the short time of six seconds. That was unheard-of speed. Remarkable time was also made in turning the monster turrets. All the air was exhausted from the compressors and the machine was started. In less than three seconds a turret weighing more than 250 tons was swinging in its circle. The compressor generated its full force of 125 pounds pressure in the short time of 45 seconds. There was no vibration to be felt in the turret, and the monster guns showed not the slightest tremor as they swung around. The turrets were turned by a simple turning engine, and the men who worked in them were not clad in oilskins, as in most turrets, but swung merrily to their work half stripped. A test was made of moving both turrets, elevating the guns and swinging the rudder by means of one compressor. In 52 seconds both turrets were completely swung around.

The speed simply astonished all the naval officers. The Trial Board consisted of these officers: Capt. P. F. Harrington, of the

Terror; Naval Constructor F. L. Fernald and Chief Engineer George W. Stivers, with Lieut. Albert Gleaves as recorder. The time allowance for sawing the helm clear over was 16 seconds. The time allowance for turning the turrets was also beaten by as large a proportion as the maneuvers with the helm.

The great test of the day was the volley firing from the 10-inch guns. This, too, was to be a time test. Five volleys were to be fired from them at intervals of not less than three minutes. The guns were to be loaded completely, without any previous preparation of ammunition. The crew had practically no drill in the work. It was found that the first gun in the after turret was loaded in 1 minute and 37 seconds. The first gun in the forward turret was loaded in 1 minute and 46 seconds. The second gun in the after turret was ready for firing in 2 minutes and 9 seconds, and the second gun in the forward turret was ready 23 seconds later. Thus all four guns were loaded inside of 2 minutes and 31 seconds. As soon as the guns were ready the signal to fire was given by a member of the Trial Board. Navigating Officer Curtis stooped over his electric battery, turned a handle swiftly, and at once the ship shook under the mighty reverberation of the four guns.

As we go to press word comes that the vessel's tests at sea have been completed and are eminently satisfactory.

Arbitration Committee Decisions.

In addition to the four items already passed upon by the Arbitration Committee for the guidance of roads during the year, and reported by us last month, the following subjects were brought to its attention at its meeting held Nov. 6, 1896, by correspondence from the members of the Association, and were considered worthy of a ruling in accordance with the instructions from the Association that the committee should make a ruling on questions arising and not settled by the rules, which ruling should stand as a part of the rules for the year:

E. When airbrake hose is missing it is evidence of unfair usage, and the cost of replacement is chargeable to the party having possession of the car.

F. There seems to be some misunderstanding also in regard to Section 49 of Rule 3, Section 15 and 16 of Rule 4 and Section 5 of Rule 5. The Arbitration Committee rules that a proper understanding is as follows:

It is the intent of the rules that a repair card should be used in all cases when repairs are made, whether such repairs are made right or wrong, or whether they are to be charged to the car owner or not.

THE MOST ADVANTAGEOUS DIMENSIONS FOR LOCOMOTIVE EXHAUST PIPES AND SMOKESTACKS.*

BY INSPECTOR TROSKE.

(Continued from page 313.)

This increase of the co-efficients is graphically shown in Fig. 75. The abscissas of both diagrams give the grate areas in square feet, while the ordinates give the values of the corresponding sectional co-efficients. The co-efficients were calculated and the diagrams drawn to express an average for large and small grate areas and for different locomotives with varying ratios. It has been found that the ordinates of the connecting line for both forms of stack lie in a straight line, from which it follows:

With an increasing grate area the sectional co-efficient increases in an arithmetical ratio.

Referring to the throwing of sparks, it may be remarked that I found this to be no greater with the experimental stack as applied to the four-coupled Erfurt locomotive than in the case of the four-coupled express passenger compound locomotive. We can thus apply a spark arrester with this stack with the same certainty of safety that we feel in connection with the compound locomotive.

The two lines of the diagram in Fig. 75 are not parallel to each other, but that of the cylindrical stack rises more abruptly than the other, and this in such a ratio that for the same abscissas the value of its ordinates is about one and a half times as much as that of the conical stack. Thus we obtain for the same ratio

The section of a cylindrical stack is $1\frac{1}{2}$ times as large as that of the waist of an equivalent conical stack with a flare of $\frac{1}{2}$.

Or the diameter of the cylindrical stack is equal to $\sqrt{1.5} = 1.2247$ times the waist diameter of a conical stack with a flare of $\frac{1}{2}$.

In consequence of the changeability of the co-efficients it is evident that an accurate calculation can only be made by basing it upon the sectional area of the tubes.

The value of the co-efficients can, to be sure, be taken from the lines of the diagram found in Fig. 75, but, in order to give an exact

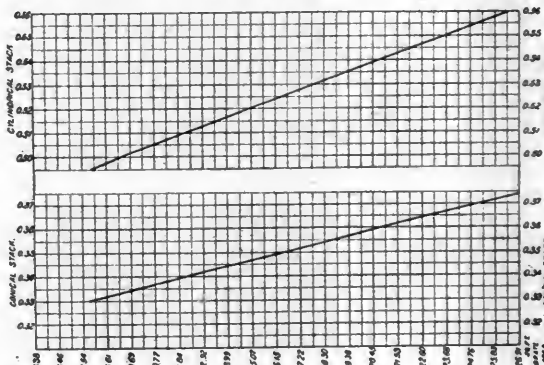


Fig. 75.

reading of the same, Table XXVIII. is appended. It gives the value of this co-efficient for 15 different limits of grate area within the limits of 9.68 square feet and 25.39 square feet. In it f_s , cyl. = the sectional area of the cylindrical stack, f_s , con. = the sectional area of the conical stack, contracted on a flare of $\frac{1}{2}$ at the waist.

TABLE XXVIII.

Grate area. Square feet.	Sectional coefficient ϕ at	
	f_s con.	f_s cyl.
9.68 to 10.22	.3350	.50250
10.76 to 11.30	.3375	.50625
11.84 to 12.38	.3400	.51000
12.82 to 13.46	.3425	.51375
14.00 to 14.54	.3450	.51750
15.07 to 15.61	.3475	.52125
16.15 to 16.69	.3500	.52500
17.23 to 17.77	.3525	.52875
18.30 to 18.84	.3550	.53250
19.38 to 19.92	.3575	.53625
20.45 to 20.99	.3600	.54000
21.53 to 22.07	.3625	.54375
22.61 to 23.15	.3650	.54750
23.68 to 24.22	.3675	.55125
24.76 to 25.30	.3700	.55500

If f_r indicates the sectional area of the tubes in square feet, the sectional area of the stack in square feet will be represented by

$$f_s = \phi f_r$$

The diameter S of the nozzle opening can be obtained from the sectional area of the tubes by means of the formula

$$f_s = \frac{\pi}{4} S^2 = 0.04 f_r$$

when f_0 indicates the sectional area of the nozzle.

A simpler method still leads one to the same result, if we calculate it directly from the diameter of the stack.

The equation referred to becomes

$$f_s = \frac{\pi}{4} d^2$$

in which d represents the diameter of the waist of stack having a flare of $\frac{1}{2}$.

The nozzle distance x is calculated as we have indicated in section III., by the formula:

$$x = (1\frac{1}{2} \text{ to } 1\frac{3}{4})d$$

for which we take the smaller value

$$x = 1\frac{1}{2}d$$

This gives, empirically, a satisfactory position.

Since it is possible to take x as equal to $1\frac{1}{2}d$, the value obtained from III. can, in cases of necessity, be increased a few inches in round numbers.

How great, now, should we make the total height H ?

In section III. it was roughly shown from the experiments with the experimental apparatus that a satisfactory construction can be obtained by making H from $4\frac{1}{2}$ to 5 times the diameter of the waist of the stack; the nozzle distance x would then become $1\frac{1}{2}d$.

In section V. we saw that it is well when H is given to make the value of l and x as follows:

$$l = (0.6 \text{ to } 0.7)H$$

$$x = (0.4 \text{ to } 0.5)H.$$

* Paper read before the German Society of Mechanical Engineers, and published in *Glaser's Annalen für Gewerbe und Bauwesen*.

In America it is well known that a considerably higher vacuum is used than in Germany. According to an article by Herr von Bornes, published in the *Annalen für Gewerbe und Bauwesen* in 1902, page 223, this vacuum frequently amounts to as much as from 12 inches to 15 $\frac{1}{4}$ inches of water. This unavoidably causes a large quantity of sparks to be carried through the tubes and is the reason for the application of the large smokebox; for, in this way, the particles of coal that are carried through the tubes can be collected in the front end and the ample space provided enables this to be done without quickly clogging the lower tubes and thus interfering with the steaming capacity of the boiler.

From this we may take as approximately the average values as follows:

$$\text{IV. } \begin{cases} l = 0.666H = \frac{2}{3}H \\ x = 0.333H = \frac{1}{3}H \end{cases}$$

From III. we now have

$$x = \frac{1}{3}d, \text{ which gives } \frac{1}{3}d = \frac{1}{3}H, \text{ or } H = d = \frac{1}{3}d.$$

V. The total height H of the stack is thus made dependent upon the diameter d of the waist. But it can, nevertheless, be increased a few inches without any hesitation.

Fig. 76 shows the necessary division of the total height of H into the nozzle distance x and the stack length l in accordance with what has just been said.

If we bear in mind the foregoing comparisons for the principal dimensions of the conical stack having a flare of one-sixth and using the diameter of the waist d as the unit of measurement we will have $l = 3d$, and the upper diameter of the stack = $\frac{1}{3}d$, which thus becomes the same as the nozzle distance x .

The ratios existing between the several dimensions of a locomotive stack are thus shown to be of the very simplest nature, as still further shown by Fig. 77.*

These ratios have been proven to be accurate and available for use not only on ordinary locomotives, as demonstrated in numerous cases, but on the whole range of express, passenger and freight locomotives, as well as upon switching engines. For compound locomotives, on the other hand, a further change is required, as an application to them has demonstrated. In consequence of their having only two exhausts for each revolution of the crank, the stack, in order to produce the same effect upon the fire, must either be somewhat smaller or somewhat longer than in the comparative dimensions given above, provided it is not thought best to modify the calculation of the increased total height by the use of a wider bridge. Experiments made on four coupled compound express passenger locomotives built at Erfurt and Hanover and six coupled compound freight locomotives gave a satisfactory working of the smokestack, if the total height was equal to five times the diameter of the waist; that is, when $5dH = 5d$, and, likewise, when $l = 3\frac{1}{2}d$. The above ratio of stack could then be taken as in the ordinary locomotive.

The foregoing rules are for conical stacks that have a flare of one-sixth over their whole length. If we wish to use a stack having another inclination, it is necessary, as we have already shown in connection with Fig. 74, to make a corresponding adjustment of the diameter of the waist as calculated in table XXVIII. for the new flare. This must be positive for a flare less than $\frac{1}{6}$ (as $\frac{1}{8}$, $\frac{1}{10}$, etc., for example), and negative for such as are greater than $\frac{1}{6}$ (as $\frac{1}{4}$, for example). It is merely stipulated that, according to

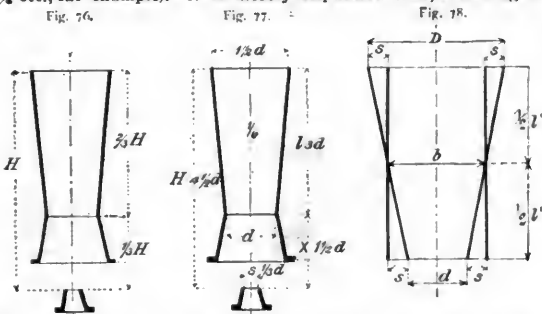


Fig. 76. The average cross-sectional area located at a distance of $\frac{1}{2}$ above the waist should remain the same. The length of l , may, however, change with the diameter d , according to the following observations:

According to Fig. 78, let the upper diameter, at a distance l^1 from the waist, be represented by D ; let σ be the average diameter, and s one-half of the difference between the largest and the smallest diameters, hence we have for a stack with a flare of $\frac{1}{6}$:

$$\begin{aligned} D &= d + \frac{1}{6}l^1 \\ D &= d + 4s \text{ and} \\ l^1 &= 24s \end{aligned}$$

The average diameter is

$$\sigma = d + 2s = d + \frac{l^1}{12}$$

which gives

$$\text{VI. a. } l^1 = 12(\sigma - d).$$

* With regard to the construction of locomotive smokestacks the recommended practice of $x = \frac{1}{3}H$ should be especially referred to Section Vb. It will be remembered that it was there shown that the lower third of the total height of the stack is without any marked influence on the action of the draft, provided that the jet of steam with its entrained accompaniment of the products of combustion find a free entrance. The latter statement tallies with the relative width of stacks that were laid down in Table XXVIII. It is, therefore, from this fact that a particular shape at this point is a matter of no moment; that the so-called "foot" of the stack has been developed. It will even be found that the stack can be lengthened downward a certain amount, thus lengthening l and shortening x , and also at the same time contracting the new diameter of the waist without in any way materially injuring the efficiency of the action of the stack. For this reason it is my opinion that many of the special bases and stacks that have been cast for individual locomotives have been a waste of time, money and trouble. They are only suitable where the distance from the nozzle to the top of the smoke-box is greater than $1\frac{1}{4}d$, or where the shell of the stack-pipe projects through the plating and comes down into the smoke-box.

Hence, as the cross section of a cylindrical stack is equal to $1\frac{1}{2}$ times that of the corresponding conical stack having a flare of $\frac{1}{6}$, we also have

$$\sigma = 1.2247 d$$

whence we obtain from VI. a

$$\text{VI. b. } l^1 = 2.6064 d = \infty 2.7 d.$$

By this equation we obtain from V. the resulting ratio of

$$d = \frac{1}{3} H,$$

whence we obtain from l^1 the simple equation

$$l^1 = 2.7 \times \frac{1}{3} H$$

or

$$\text{VI. c. } l^1 = 0.6 H.$$

When the simple length of stack l (see Fig. 76) is, according to 12, equal to $0.666 \dots H$, so that it happens that for the change in the flare of the stack, the corresponding length l^1 is about $\frac{1}{3} H$ shorter than before. Therefore if we wish to keep the length l constant it will be necessary to enlarge the stack.

In the summary given at the conclusion of this paper, the differences between the diameters of the cylindrical and equivalent conical stacks having a flare of $\frac{1}{6}$ is given in a separate column: which was averaged from a series of experiments with an indicated stack, and calculated.* If this difference be multiplied by 12 in accordance with VI. a we will have l^1 .

If the diameter of the cylindrical stack is not calculated, l^1 will either be fixed according to VI. b or, simpler still, according to VI. c. In compound locomotives l^1 will likewise be large as in ordinary locomotives. If H be assumed then l^1 will be equal to $0.54 H$, according to the first and larger values of H ($= 5 d$).

As soon as l^1 is determined, then the necessary enlargement of the waist of a stack having a flare of $\frac{1}{6}$ can be calculated. An example may make this clearer.

Let us take, for instance, a locomotive having a grate area of 24.73 square feet, the sectional area of the tubes being 3.12 square feet. According to equation I and table XXVII, a conical stack having a flare of $\frac{1}{6}$ will have a sectional area at the waist, $fs = .37 \times 3.12 = 1.15$ square feet, which gives $d = 14.57$ inches and $H =$

* Example I. The eight-coupled consolidation compound freight locomotive of the Prussian State Railway required, according to the conclusion given in the general review in section XII., and with a stack having a flare of $\frac{1}{6}$, a diameter of waist of 16.14 inches, with the total height $H = 5 \times 16.14 = 80.7$ inches; $l = 3\frac{1}{2} \times 16.14 = 56.49$ inches, and the nozzle distance $x = 1\frac{1}{2} \times 16.14 = 24.21$ inches. The nozzle diameter thus becomes $\frac{1}{6} \times 16.14 = 5.71$ inches. If we make the flare of the stack $\frac{1}{8}$ instead of $\frac{1}{6}$ the diameter of the waist must be made $16.14 + 1.81 = 17.95$ inches, whence l^1 , according to equation VI. b is equal to $2.7 \times 16.14 = 43.58$ inches.

Owing to the high position of the boiler on this locomotive it was impossible to get a total height of stack of 80.7 inches. In fact it could only be made about 53.14 inches. The calculated stack had, therefore, to be shortened about 27.56 inches, which means that the length l was $56.59 - 27.56 = 29.03$ inches. According to Plate IV., under IV., it appears that a funnel-shaped stack, 4 feet 9.68 inches long, when shortened 27.56 inches, shows a diminution of the vacuum of about .87 inches of water, the abscissa being $24.21 + 17.52 = 41.73$ inches and the nozzle diameter 5.32 inches. The shortened stack must then be given such an increase of flare that this lowering of the vacuum will be compensated. According to the said Plate IV., we find that this contraction will amount to about 1.97 inches, for the stack with a flare of one-twelfth, with a diameter of 15.75 inches, when shortened 27.56 inches, shows a vacuum of 3.7 inches at an abscissa of 3 feet 5.73 inches, which with a stack of the same length, but having a diameter of 13.78 inches, shows a vacuum of 4.69 inches, both nozzles having a diameter of 5.32 inches (a mean between 5.51 inches and 5.12 inches), or a difference of .89 inches. The diameter of the waist, which was 17.95 inches, thus becomes in the new stack of one-twelfth flare only about $17.95 - 1.97 = 15.98$ inches, with a length $l = 28.94$ inches and a nozzle distance $x = 24.21$ inches. The eight-coupled consolidation locomotive in question worked satisfactorily with a waist diameter of 15.75 inches; a length $l = 28.55$ inches and a nozzle distance $x = 24.02$ inches, while the nozzle diameter is 5.12 inches.

Example 2a. The eight-wheeled, four-coupled compound express locomotive of the Prussian State Railway permits the use of a total height of stack H of about 5 feet 4.96 inches, provided the nozzle is not placed below the upper row of tubes. According to the statement already made, the stack, having a flare of $\frac{1}{6}$ must have a waist of 11.53 inches in diameter; H would then be equal to $5 \times 11.53 = 72.65$ inches in round numbers; $l = 51.18$ inches and $x = 1\frac{1}{2} \times 11.53 = 21.73$ inches in round numbers, and the nozzle diameter must be 1.86 inches. The calculated length of stack thus becomes 7.87 inches shorter, that is to say l will be equal to 43.31 inches. According to Plate IV., under IV., the length of a funnel-shaped stack with a flare of $\frac{1}{8}$ is 4 feet 9.68 inches with a nozzle diameter of 4.74 inches and a diameter itself of 15.75 inches, producing a vacuum of 4.69 inches, which drops to 3.94 inches with a stack length of 4 feet 3.18 inches, and to 3.66 inches, with a length of 3 feet 7.31 inches. Shortening the stack 7.87 inches also lowers the vacuum from 3.94 inches to 3.66 inches, or .28 inch. This slight fall can be made up by the application of a bridge.

According to Plate VI, under D, with an abscissa of $21.65 + 17.52 = 39.17$ inches, the vacuum of a funnel-shaped stack 4 feet 9.68 inches long, with a flare of $\frac{1}{8}$ and a diameter of 15.75 is increased about .37 inch by cutting down the stack 15.75 inches at the top, if, at the same time, instead of a nozzle 4.74 inches in diameter one with a bridge .36 inch wide and 5.12 inches in diameter is used. But since, in this case, compensation must be made for only .27 inch, a somewhat narrower bridge can be used. This locomotive, with a stack having a flare of $\frac{1}{8}$, a diameter of 16.14 inches (having been substituted for one with a flare of $\frac{1}{6}$ and a diameter of 14.53 inches) with $l = 43.31$ inches = 21.65 inches and a nozzle 5.12 inches in diameter provided with a bridge, generated sufficient steam for its work and yet threw less sparks than the old and smaller stack had done.

b. The same good results were also obtained with a stack .59 inch smaller, while the other dimensions were kept the same as in the stack of 16.14 inches diameter just mentioned. According to the plates, the vacuum was increased about .27 inch by this contraction of .59 inch. If a bridge .35 inch wide is used the diameter of the nozzle can be increased to 5.32 inches.

c. By dropping the nozzle down below the top row of tubes, the calculated total height, $H = 6$ feet 0.81 inch, of stack can be obtained. On an eight-wheeled, four-coupled compound express locomotive, the fire was worked in a satisfactory manner, with a cylindrical stack having a diameter of 17.73 inches, a length of stack proper of 2 feet 2 inches and a nozzle distance of 22.84 inches and a nozzle diameter of 5.12 inches provided with a bridge .31 inch wide, and this too when the engine was severely crowded.

$4\frac{1}{2} \times 14.57 = 65.66$ inches, = 5 feet, 5.66 inches, l' will then be equal to 2.7×14.57 or $0.6 \times 65.66 = 39.4$ inches (1 m.).

whence $\frac{l}{2} = 19.7$ inches. (500 mm.).

In a height of 19.7 inches the contraction at the bottom is the same as the widening at the top.

In stacks with $\frac{1}{4}$ flare we have $\frac{19.7}{6} = 3.28$ inches.

" " " $\frac{1}{8}$ " " $\frac{19.7}{8} = 2.46$ "

" " " $\frac{1}{16}$ " " $\frac{19.7}{10} = 1.97$ "

" " " $\frac{1}{32}$ " " $\frac{19.7}{12} = 1.64$ "

Etc.

Again the stack with a flare of $\frac{1}{4}$ has a smaller waist than the—
Stack with a flare of $\frac{1}{8}$ by $3.28 - 2.46 = .82$ inch.

" " " $\frac{1}{16}$ " " $3.28 - 1.97 = 1.31$ inches.

" " " $\frac{1}{32}$ " " $3.28 - 1.64 = 1.64$ "

Thus the adjustments 2 for the diameter of the waist calculated in accordance with Table XXIII. are established.

By maintaining a greater diameter of stack at the waist, the nozzle distance, as calculated according to equation III., remains unchanged as well as the total height H , together with the nozzle diameter that was calculated according to II. b. Now, if our stack having a flare of $\frac{1}{4}$ is replaced by one with a flare of $\frac{1}{8}$, the diameter of the latter would then be, in round numbers, $14.57 + 1.61 = 16.18$ inches. It would have a total height of $H = 14.57 + 4.5 = 65.57$ inches, $l = \frac{1}{2} \times 65.57 = 43.78$ inches, and the nozzle distance $x = \frac{1}{2} \times 65.57 = 21.88$ inches, while the diameter of the nozzle itself would be $\frac{1}{2} \times 14.57 = 4.86$ inches.

If we make an application of these dimensions to a compound locomotive having the same grate area and sectional area through tubes, H and l will be increased by about $\frac{1}{2}$ d., so that $H = 72.84$ inches and $l = 50.98$ inches. All of the other dimensions, as well as the converted length l' , will be the same as in the ordinary locomotive.

From the foregoing discussion of the change in the flare of the stack it is evident that advantage should be taken of its peculiarities if the dimensions of different stacks are to be so adjusted as to make a comparison of their action with each other. To do this they must be changed to the same flare; furthermore, it is also necessary to bear in mind the different nozzle distances, that these may also be made the same for the purpose of a calculation, and whether the stack itself has actually been lengthened or shortened. Then a fresh comparison of the stacks with reference to their diameters and lengths becomes possible.

In this way it is often found that on locomotives with ratios already established the stack is too small for a large nozzle opening, and on the other hand the stack is too large for the small opening. According to the deductions obtained from sections III. to V., the same vacuum can be produced with both arrangements. According to the statement made in V., the latter arrangement (the large stack) is usually the one to be preferred, especially, and this must be distinctly emphasized—there should never be too great a contraction of the nozzle opening (the calculation being correct) lest there be a corresponding back pressure put upon the steam piston, as a result, as was clearly shown by the Templehof experiments. This inter relationship existing between the stack and the nozzle must be kept constantly before the eye in the determination of the dimensions to be given to these parts. No accurate rule for the influence and action of the draft upon the fire is rendered possible by the knowledge of the dimensions of only one of these parts.

The stack and the nozzle must, rather, always be examined together.

According to the deductions obtained from Section XI., it is seen to be purely a matter of taste as to what shape of stack shall be used, whether cylindrical or conical, especially as the cost scarcely enters into the question.

When it so happens that the height available in the construction is not as much as that demanded by equations V and V_a , then the shortened stack must be made correspondingly smaller. The lines of the diagrams in Plates III. and IV. show this without any further rule. If the stack is made a few inches longer than the established length, as in the case of a tank locomotive, for example, where it was done for the sake of avoiding a smoke annoyance to the men; then, if the action of the draft is to be kept the same, it must be made larger in diameter according to Table XXVIII. The Plates mentioned also give the necessary data.

It must be remembered just here that the value of the vacuums given in these tables must be understood to be only approximations for general application. They were obtained on the experimental apparatus under the conditions existing on a passenger locomotive, and therefore coincide in the first line with that of those locomotives of similar conditions and sizes. But the latter ones are only definite for the first position of the air openings; still, as the draft ratios of all locomotives are very much alike, the results obtained by these experiments can be adapted to a general application and the plates admit of being transferred to locomotives of a different kind.

For the purpose of making an average of the conditions prevailing in practice, locomotive experiments were instituted, using both pure Silesian coal and a half and half mixture of this and of Westphalian coal. When a stack designed in accordance with the foregoing rules failed to make steam enough on account of the fuel used, the draft could be readily adjusted and made sufficient by the application of a bridge to the nozzle.

Still, it is not alone the kind of fuel that influences the draft in a way that the formulae cannot be applied in a definite manner, but particularly that wide variety of arrangement that prevails in the designs of locomotive boilers and their appurtenances, such as

similar grate areas and sectional areas through the tubes. Greater length of flues and closer meshes in the spark arresters may likewise diminish the draft and necessitate a variation from the calculated dimensions. The simplest way of meeting this difficulty is, as we have already demonstrated, by the application of a bridge to the exhaust nozzle. Suppose, for example, that the draft is too weak, it can readily be strengthened by the application of a bridge of a suitable width, while the diameter of the nozzle is also increased. Suppose it is too strong, it is, on the other hand, merely necessary to bore out the nozzle to a larger diameter, or, in case a bridge is already there, it can be made narrower or a smaller one substituted in its place. By this means, especially on the trial of a new type of locomotive, we can advantageously make the change if we desire to test the steam-generating qualities. Likewise, it may be desirable to furnish the driver with a few bridges of different widths and depths that vary from each other by from .05 to .10 inches, with instructions to try them one after another until the best possible draft on the fire is obtained.

In most cases a bridge from .20 inch to .27 inch in width and from .10 inch to .20 inch in height will suffice for increasing the draft a suitable amount, so that in general the nozzle may be made a few hundredths of an inch larger in diameter than that called for by the calculations. It was also shown by the experiments mentioned above that no marked increase in the back-pressure on the pistons is to be feared as the result of the application of so small a bridge. But if it is desired to make a considerable increase in the strength of the draft it becomes necessary to adopt a

Fig. 79

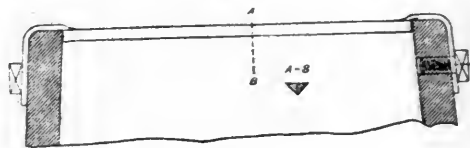


Fig. 80.

PLAN FROM BELOW

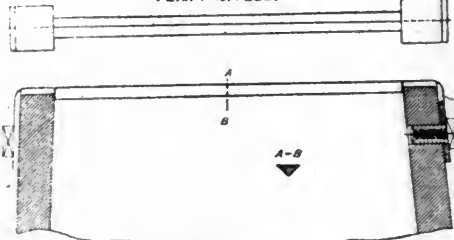
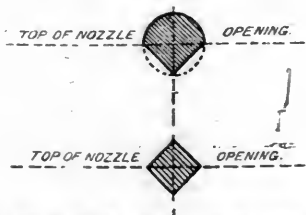


Fig. 81



wider bridge, say from .39 inch to .47 inch, and at the same time increase the diameter of the nozzle from .20 inch to .39 inch, by which means the steam jet will be given a sharper divergence and thus fill the stack more quickly. An example of this is furnished by the case of an eight wheeled, four-coupled Erturt locomotive, the diameter of whose nozzle was calculated at 5.02 inches, but which was actually made 5.12 inches, and a bridge .31 inch applied. In consequence of this, with a conical experimental stack 14.96 inches in diameter at the waist and a flare of $\frac{1}{4}$ (the length being like that given in the annexed review at the conclusion of this article), the calculated nozzle distance could be decreased from 22.44 inches to 8.5 inches. In the same way on a locomotive of similar construction, a cylindrical stack, having a diameter of 18.70 inches, was taken instead of the calculated size of 18.31 inches, since the same nozzle (5.02 inches in diameter) was enlarged to 5.19 inches, and a bridge 43 inches wide applied. In both cases the consumption of fuel and the generation of steam was satisfactory.

With the cylindrical stack the nozzle opening was placed so low that it was almost flush with the top row of tubes, so that the proper constructional height H was obtained. It is well known that this low location of the nozzle has had many applications on the large English locomotives, among others on the so-called single-driver engines of the Great Northern Railway, which, with drivers

The Situation in China and Japan.

(WRITTEN FOR THE AMERICAN ENGINEER.)

It is to the interest of American manufacturers of railroad material, cars, etc., that they should understand the changes in China effected by the late war in Japan. Before the peace of Shimonoseki, the Chinese mandarins violently opposed the introduction of any innovation, threatening to do away with their influence and perquisites. But since peace was restored, two powerful influences have been at work among them. First comes the hatred inspired by the success of the despised Wo-Jin, or pigmies, as they contemptuously name the Japanese; and second the fear of dismemberment unless China acquires the means of consolidating her strength. Besides these impulses working internally, the Japanese have been instrumental in removing the barrier which kept the interior of China closed to foreign enterprise. This fact is so important that some space may be devoted to an explanation.

When peace negotiations between Li Hung Chang and Marquis Ito were in progress in Shimonoseki, the Japanese Prime Minister feared that England would object to the cession of the Liao Tung Peninsula. To propitiate this power, Ito insisted upon the insertion of the following three clauses:

1. The opening of several new ports.
2. The right of Japanese subjects to manufacture in the open ports of China; and
3. The abolition of the li-kin duty.

As to the first clause, this was simply establishing so many new markets for foreign products; but as these ports are situated in the poorer districts of China, the advantage to foreigners was not great. Another thing, however, was the second clause. The right of manufacturing had been reserved to the mandarins, but by the "favored-nation" clause of China's treaties with other nations, no privilege whatever can be granted to any nation which is not shared by all alike. This clause, then, threw China open to foreign manufacturers, and many were not slow to avail themselves of cheap wages, cheaper coal and transportation.

But the most important of all clauses was the abolition of the li-kin duty. The import duty in China is almost uniformly 5 per cent. *ad valorem*, and is immutable, being regulated by treaty, while China neither demands nor is likely to obtain tariff autonomy within our lifetime. But the mandarins have appropriated to themselves the right to collect a toll on all merchandise passing through their territory. The rivers are the great arteries of trade, but these magistratures are very close together, so that the frequency of this toll acted in reality as a prohibitory tariff. Its abolition has therefore opened China to foreign manufactures.

Up to the close of the war the only railroads existing in China were from Tientsin to Shanghai Kwan, 25 miles, and from Tientsin to the Kai Ping coal-fields owned and operated by Li Hung Chang. This last-named road is 67 miles long. Both roads are the property of the wealthy viceroy, but are wretchedly equipped and managed. Li Hung Chang's great rival in power was and is to-day Chang Chih Tung, who, while still in Peking, advocated the construction of railroads, but with Chinese capital and under China control. Through Li Hung Chang's influence he was appointed viceroy of the two Kiangs' wealthy provinces about the Yang-tse River, and of which Nanking is the capital. Here he was told to carry out his projects, and he proceeded to do so in a characteristic Chinese way.

He decided first to intrust the building of railroad shops to a nationality not powerful enough to make its influence felt, and his choice fell upon Belgium. He engaged as chief engineer Mr. Paul de Hees, who had constructed many of the railroads in Turkey, and a staff of engineers of the same nationality and located the shops at Hankow, 400 miles up the Yang-tse. The work was, however, taken up and carried on in a most desultory and unsatisfactory manner until after the close of the war. Surveys have been made for the line between Nanking and Peking, a distance of 1,407 miles, and the work is now going on with more energy.

Mr. de Hees is a great admirer of American railroads and railroad material. He has visited this country, and is determined to

closely follow the system in use here. A Belgian firm in Shanghai, Messrs. van der Stegen & Company, are the financial agents. Here, then, would appear to be an opportunity that should not be neglected.

For energy and commercial enterprise in that part of the world the Baldwin Locomotive Works, of Philadelphia, Pa., deserve great commendation. After the World's Fair they despatched Capt. W. H. Crawford to Japan, and he succeeded, after a severe trial on the steep Gotemba grade, in the Hakone Mountains, in convincing the Japanese of the superiority of the American over the British engine. Since that time he has sold to the Japanese government and various private railroad companies over 120 locomotives, besides a number to the Russian-Siberian Railroad in Vladivostok. The same company has recently obtained an order from the Chinese government.

This action on the part of the Baldwin Locomotive Works proves conclusively that in China and Japan we can compete with any nation in Europe. In fact, we have the advantage in the time necessary to fill orders, and in cheap transportation. There are at present six steamship companies, with an aggregate of 20 steamers plying between the Pacific Coast and China, calling at Japanese ports. Besides these there are the Perry and Barber lines running from New York through the Suez Canal to Yokohama and calling at Chinese ports. The freight via these lines ranges between \$5 and \$6 per ton.

The Society of Mechanical Engineers.

The programme of the December meeting of the American Society of Mechanical Engineers shows that at the opening session, Tuesday, Dec. 1, John Fritz will read the president's address on the "Progress in the Manufacture of Iron and Steel in America and the Relations of the Engineer to It." On Wednesday morning these papers are to be presented: "An Historical and Technical Sketch of the origin of the Bessemer Process," by Sir Henry Bessemer; "Ancient Pompeian Boilers," by Wm. T. Bonner; "The Moment of Resistance," by C. V. Kerr; "Work Done Daily by a Refrigerating Plant and Its Cost," by Francis H. Boyer; "Promise and Potency of High Pressure Steam," by R. H. Thurston. The afternoon session will be devoted to addresses in memory of J. F. Holloway.

Thursday morning will be devoted to the following papers: "Experimental Investigation of the Cutting of Bevel Gears with Rotary Cutters," by F. R. Jones and A. L. Goddard; "The Calibration of a Worthington Water Meter," by J. A. Laird; "Contraction and Deflection of Iron Castings," by Francis Schuman; "A 200-foot Gantry Crane," by John W. Seaver; "Washing of Bituminous Coal by the Lubrig Process," by J. V. Schaefer; "Friction H.-P. in Factories," by C. H. Benjamin. In the afternoon these papers will be presented: "Some Special Forms of Mechanical Computers," by Frederick A. Halsey; "Rustless Coatings for Iron and Steel," by M. P. Wood; "A Method of Shop Accounting to Determine Cost," by H. M. Lane; "Tests of Fireproofing Material," by H. de B. Parsons.

Friday's session will be occupied with the following papers: "The Efficiency of the Boiler Grate," by W. W. Christie; "Efficiency of Boiler Heating Surface," by R. S. Hale; "Paper Friction Wheels," by W. F. M. Goss; "Steam Engine Governors," by Frank H. Ball; "Metric vs. the Duodecimal System," by Geo. W. Colles, Jr.; "Aluminum Bronze Seamless Tubing," by Leonard Waldo, and "The Photographing of Machinery," by Leonard Waldo.

Association of Railway Superintendents of Bridges and Buildings.

At the annual meeting of this Society at Chicago in October, the following officers were elected:

President, James Stannard, Wabash.
First Vice-President, Walter G. Berg, Lehigh Valley.
Second Vice-President, Joseph H. Cummin, Long Island.
Third Vice-President, Aaron S. Markley, Chicago & Eastern Illinois.

Fourth Vice-President, R. M. Peck, Missouri-Pacific.
Secretary, S. F. Patterson, Boston and Maine.
Treasurer, N. W. Thompson, Pittsburgh, Fort Wayne & Chicago.

The following subjects were selected for committee reports to be presented at Denver next year:

1. Methods of Heating Buildings where Three or More Stoves are now Used.

2. The most Suitable Material for Roofs of Buildings of all Kinds.
3. Round-house Construction, including Smoke-Jacks and Ventilators.
4. Care of Iron Bridges after Erection.
5. How to Determine Size and Capacity for Waterways.
6. Protection of Railroad Buildings and other Structures from Fire.
7. Designs for Ice Houses.
8. Best End Construction for Trestles Adjoining Embankments.
9. Bridge Warnings for Low Overhead Structures.
10. Stockyards and Stocksheds, Including all Details of Construction.
11. Floor System on Bridges, Including Skew Bridges.

Trade Catalogues.

[In 1894 the Master Car-Builders' Association, for convenience in filing and preservation of pamphlets, catalogues, specifications, etc., adopted a number of standard sizes. These are given here in order that the size of the publications of this kind, which are noticed under this head, may be compared with the standards, and it may be known whether they conform thereto.]

It seems very desirable that all trade catalogues published should conform to the standard sizes adopted by the Master Car-Builders' Association, and therefore in noticing catalogues hereafter it will be stated in brackets whether they are or are not of one of the standard sizes.]

THE GOUBERT WATER TUBE FEED WATER HEATER. The Goubert Manufacturing Company, New York. 48 pages. 6 by 9 inches. (Standard size.)

In March, 1895, we noticed and criticised a catalogue which was issued by the above company about that time. The burden of the criticism was that the commendation of the heater came first and the explanation of its construction afterward, and that the latter was inadequate for a full understanding of the apparatus. We have now received a new catalogue issued by the same company which is a model of its kind. It begins with an admirably clear description of "What a Feed Water is." Then the distinction between "open" and "closed" or "pressure heaters" is explained, and the objections to the former pointed out. The construction of the Goubert heater is then fully described and illustrated by sectional views, so that the wayfaring man and his coadjutant may readily understand it. A section is devoted to directions for erecting and running the apparatus, with an excellent wood engraving showing an engine-room and the disposition or location of the engine, heater, separator, steam pump, etc. Another section is on the use of heaters with condensing engines, which is followed by illustrations of several different forms, tables of sizes and price lists, and showing the percentage of fuel saved by heating feed water, and the yearly saving under differing conditions. A list of reference occupying 13 closely printed pages and a description of the Stratton separator complete the volume. It is admirably printed on best coated paper, the engravings could not be better, and altogether it is an example of the best type of this kind of literature.

WESTINGHOUSE GAS ENGINES. Manufactured by the Westinghouse Machine Company, Pittsburgh, Pa. 19 pages. 6 by 9 inches. (Standard size.)

This is apparently a sort of introductory volume to a fuller descriptive circular which is now in course of preparation. During the past two years Mr. George Westinghouse, Jr., has been engaged with the aid of the best obtainable engineering talent in developing and improving a form of gas engine which is illustrated and somewhat meagerly described in the publication before us. A large amount of money has been expended in experimental work and in perfecting a gas engine which it is here announced the company is now ready to supply. The general external appearance of the engine is similar to the well-known Westinghouse steam engine, but the description is only of the general features, which are embodied in this new departure. New shops have been built at East Pittsburgh, and the company announce that they have abundant facilities to supply this new type of engine.

ENGINE AND BOILER CATALOGUE. Houston, Stanwood & Gamble, Cincinnati, O. 32 pages. 8 by 10 1/4 inches.

This firm in the introduction to their circular say that they manufacture nothing but slide-valve engines, and that with good workmanship and high steam pressure that there is little difference in their economy compared with high-speed automatic engines. In the pamphlet which has been issued the different types of slide-valve engines which the firm manufactures are described with illustrations of details of different parts, reports of performance, etc. A separate section is devoted to flue and tubular boilers, with tables of dimensions, capacity, etc., and an excellent illustrated descrip-

tion of methods of setting boilers, boiler fronts, etc., and also an illustration and description of a coil feed-water heater which they make.

THE HANCOCK LOCOMOTIVE INSPIRATOR, manufactured by the Hancock Inspirator Company, 51 Oliver street, Boston, Mass., 1890; 16 pages, 6 by 9 inches (standard size).

In a circular letter accompanying this catalogue the manufacturers state that they designed and placed on the market the first double-tube locomotive boiler feeder, and that their constant aim has been to produce an instrument that in simplicity, durability and efficiency will best meet the severe requirements of locomotive service. As the company's sales of Hancock Inspirators of all kinds has been more than 200,000 in 20 years, it is evident that good design and workmanship has characterized these boiler-feeders. In the present catalogue the company present three styles or types of the Hancock Inspirator, A, B and D, some one of which is interchangeable with any injector of standard manufacture now on the market. An important fact in connection with this statement is that each and every corresponding part of the three types (A, B and D) is identical in design and interchangeable, the only exception being the bodies, which are shaped to suit the different pipe connections, and the connecting rods and overflow cranks. This will readily be recognized as an important advantage in substituting one standard for the different makes of injectors in use and in the matter of economy when repairs may be necessary.

Besides the illustrations of these inspirators and tables of their prices, capacities and pipe connections, there is a good description of the company's patent hose strainer, which is removable for cleaning without disturbing the coupling or any pipe joints; also check-valves and steam-valves for inspirators, and the Hancock ejectors or "lifters."

Equipment Notes.

The Illinois Central is asking for bids on 1,000 freight cars.

The Lake Erie & Western will soon order some new locomotives.

The Chicago, Hammond & Western, is in the market for 100 box cars.

The Gulf, Beaumont & Kansas City will soon place orders for 40 box cars.

The order which the Baldwin works received from China was for eight locomotives.

The Mobile & Ohio has ordered six locomotives from the Rogers' Locomotive Works.

The Armour Packing Company of Kansas City is asking bids on 100 refrigerator cars.

The Fall Brook Railway is contemplating the purchase of two passenger locomotives.

The Delaware & Hudson, it is said, will order new cars and locomotives before next March.

The Wells & French Company, Chicago, are building 400 refrigerator cars for Swift & Company.

The Wabash road is in the market for 20 10-wheel locomotives, 15 for freight and five for passenger service.

The Columbus, Hocking Valley & Toledo is reported to have placed an order with the Michigan-Peninsular Car Company, for 50 30-ton dump coal cars.

The Haskell & Barker Car Company is reported to have an order for 1,000 box-cars for the Chicago & Northwestern Railroad, and another 1,000 for the Wisconsin Central.

The Mount Vernon Car Manufacturing Company is building 25 refrigerator cars for the Mobile & Ohio. They will be of 60,000 pounds capacity and will be equipped with air-brakes, Gould couplers and Detroit springs.

The Barney & Smith Car Company, of Dayton, O., are completing 10 combination baggage and passenger cars for the B. & O. R. R. They are to be painted royal blue with gold striping, which has been adopted as the standard color of the road.

The Ohio Falls Car Company is building for the Rio Grande, Sierra Madre & Pacific Railway eight coaches, three cabooses and 150 box-cars of 60,000 pounds capacity. All the cars will have air-brakes

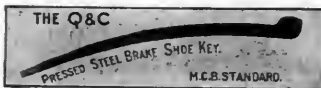
and Tower couplers, and the box-cars will also have Winslow roofs and Q. & C. door fastenings.

A contemporary, *Hardwood*, states that a gentleman, the head of one of the largest railroad systems in the country, computes that the railroads of the country will require at least 200,000 freight cars in the next two years, of which fully three-fourths will be box-cars. The construction of these cars will consume 600,000,000 feet of lumber.

Some very severe tests have been made with the royal blue tint, which has been characteristic of the Washington and New York trains of the Baltimore & Ohio Railroad. It has been found that this color meets all the requirements, and it is probable that in the near future the entire passenger equipment will be so painted and the B. & O. have a distinctive color for all its trains.

The Q & C Pressed Steel Brake-Shoe Key.

The Q & C Company, Western Union Building, Chicago, Ill., have recently acquired all rights to manufacture the pressed steel brake-shoe key, known as "The Drexel," and as the company has every facility for manufacturing them they will carry a large stock and will be able to supply them promptly and at low prices. The key, which is shown herewith, is much lighter than forged keys but it is very strong. It is cheaper than a forging and it conform



exactly to the Master Car Builders' standard in every respect. All the brake-shoe keys of this design are remarkably uniform in size and strength, and in addition to the economy they save the annoyance and trouble of forging such small work in the smithshop. The key is hereafter to be known as "The Q & C." Prices in large or small quantities can be had by writing to the company.

The Roberts Water-Tube Boiler.

The Roberts Safety Water Tube Boiler Company was incorporated in 1890, and notwithstanding the business depression that has existed throughout the country during several of the six years of the company's existence, its business has grown steadily and has assumed large proportions. The capital stock of the company is \$250,000, and last month it declared its sixth consecutive annual dividend of 10 per cent. It has built nearly 900 boilers; ranging from those suitable for small launches up to installations of nearly 2,000 horse-power in one vessel. It is claimed that the works of this company are larger than any other plant in the United States devoted exclusively to the construction of marine water tube boilers. The tools are of the most modern type, nearly \$30,000 having been expended in adding to them during the past year.

Although the Roberts Company are the owners of a number of patents on water-tube boilers, they have found that, all things being taken into consideration, the original type gives the best satisfaction, with some slight improvements in its construction and material. With the possible exception of one different type which has since been practically discarded by its manufacturer, the Roberts boiler is the father of all the marine water-tube boilers now being manufactured in this country, and it has attained an enviable reputation throughout the greater part of the civilized world. The original boiler, built by Mr. Roberts in 1879, is still in use, although it was infinitely inferior to anything built at the present day. The Roberts boilers have an excellent record for reliability also, for not one of them has ever killed a man or produced a disastrous explosion.

The Falls Hollow Staybolt.

Most of our readers are familiar with the staybolts made by the Falls Hollow Staybolt Company, of Cuyahoga Falls, O. The material employed in their manufacture is the best-hammered charcoal iron, and the company guarantees its product to be the equal if not the superior of any brand, domestic or imported, in the market. The Southern Railway recently tested some of these bolts

and the following is the result obtained, which we take from a facsimile of the report:

Area in square inches.	Elastic limit per square inch.	Ult. tensile strength per square inch.	Elongation in eight inches.	Remarks.
.537	31,600	51,000	31.25%	Fracture fibrous.

The manufacturers recently received from Mr. Barnes, of the Wabash road a letter, in which an excellent tribute to the quality of these staybolts is given. The letter is as follows:

SPRINGFIELD, Ill., Nov. 4, 1896.

Falls Hollow Staybolt Company, Cuyahoga Falls, O.

GENTLEMEN: Specifications of standard Wabash engines have been recently issued, and the proposition is to be in the market for a number of these locomotives.

In these specifications I have enumerated Falls Hollow staybolts, in confidence that they are the best we can buy for the purpose intended.

I bespeak for this company the best bolt you can make. We want the same bolt which you advertise as your standard goods.

Yours truly, J. B. BARNES.

S. M. P. and M. Wabash Road.

The bolts are made in all sizes from seven-eighth inch to two inches outside diameter, and from one-eighth inch to three-quarter inch inside diameter, depending somewhat upon the outside diameter, though considerable of a choice in the relation between the two diameters is given in the company's list of standard sizes.

The Manufacturers' Advertising Bureau has now been some six months at its new location, 136 Liberty street, New York City, and finds the move from the old-time headquarters at "111" to have been a good one. The present facilities of the Bureau are thoroughly up-to-date, and enable it to care for the large business entrusted to its care to the utmost satisfaction of its clients and with the greatest degree of convenience and dispatch. There is no other concern in the United States quite like the Manufacturers' Advertising Bureau in the business it conducts, which is original and peculiar to itself. Established in 1879 by its present head and proprietor, Mr. Benj. R. Western, who was for some years previously a publisher of trade journals, its purpose is to manage the newspaper work and advertising for firms who have not the time, inclination or experience to conduct this department of their business themselves, and yet wish brought to it the attention it deserves. The Bureau is an authority on trade-journal advertising, to which it has confined its operations almost wholly, and those in need of expert help in this direction will do well to note the fact. A booklet with the title "Advertising for Profit" is published by the concern for gratuitous distribution to manufacturers generally who are desirous of knowing just how it works.

The new plant of the Fox Pressed Steel Company, at Pittsburg is nearing completion, and will soon be ready for operation.

It is reported that the Newport News Ship Building & Dry Dock Company will enlarge some of its shops in the near future.

The Colorado Fuel & Iron Company, Pueblo, Col., are said to have an order for 10,000 tons of steel rails from the Santa Fe Railroad.

A new Pintsch gas plant is being erected at Pittsburgh for the benefit of the B. & O. R. R., which has adopted this light for its passenger trains.

The Bass Foundry & Machine Works, Fort Wayne, Ind., is said to have closed a contract to furnish a large railway system with car wheels to the amount of over \$500,000.

At the recent annual meeting of the stockholders of the Westinghouse Air Brake Company, it was shown that the gross business for the previous year amounted to \$5,947,600 and that the assets are \$2,607,936.

The Rand Drill Company has received orders for compound air compressors for the Great Northern and the Chicago, Rock Island & Pacific. One of their compressors was recently started in the Gladstone shops of the St. Paul & Duluth.

A large barge for the Hartford & New York Transportation Company was launched last month from the Gildersleeve shipyard, Hartford, Conn. It is 190 feet long and 34 feet beam, with a carrying capacity of 1,350 tons on a draft of 11 feet.

The Laidlaw-Dunn-Gordon Company, of Cincinnati, is building three large air compressors for the Baltimore & Ohio road, and a number of steam pumps for the same road. The company also has some good orders from the Illinois Central and the Chesapeake & Ohio roads.

The Harlan & Hollingsworth Company, of Wilmington, Del., have a contract from the Merchants & Miners' Transportation Company, of Baltimore, Md., for a steel steamer for the company's Baltimore and Boston line. The boat is to be a fine one, and of the following dimensions: Length, 293 feet; beam, 42 feet; depth, 34 feet.

The Babcock & Wilcox Company have furnished two boilers to the New Castle, Pa., Electric Railway Company. The Buckeye Engine Company, Salem, O., have built two cross compound engines of 500 horse-power each for the same plant. The Hall Steam Pump Company, of Pittsburg, have furnished the condensers.

During the last few months the Westinghouse Machine Company Pittsburg, Pa. have shipped the following compound engines abroad: To Algeria one 80 horse-power; to Belgium one 330 horse-power, and two 100 horse power; to France one 1,200 horse-power. In addition they have shipped a large number of Standard and Junior engines during the same period.

The Franklin Steel Casting Company, Franklin, Pa., manufacturers of steel casting, have added to their plant a number of buildings, tools, cranes, furnaces, etc., and they now possess one of the largest steel-casting plants in the country. This company manufactures the Lone Star steel coupler. It is prepared to make steel castings of all kinds up to 60,000 pounds weight.

A contract for 25 air compressors and 25 air receivers, of medium and small sizes, has been closed by the Clayton Air Compressor Works, Havemeyer Building, New York, with one company, delivery of the entire order to be made within six months from date. They also report sales of five air compressors of standard pattern during the first week in November, and the indications point to a decided revival of trade in air compressors many orders having been held in abeyance, pending the result of the election.

The Westinghouse Air-Brake Company has completed arrangements for the manufacture of air brakes at Hamilton, Ontario. The buildings of the McKennie Machine Company, at Hamilton, have been purchased, and application has been made for a Canadian charter for the Westinghouse Manufacturing Company, Limited of Hamilton. The capital stock of the new concern will be \$500,000. The best modern machinery will be installed in the plant. The capacity will be about 1,000 sets of air-brakes a week. The object of locating in Canada is, of course, to avoid paying duty on brakes sold in Canada, which is about 35 per cent., or nearly \$14 per set of brakes. The General Manager of the new works will be George F. Evans; Secretary, Paul Myler; General Superintendent, M. E. Wallace.

Messrs. R. Ulrich and Charles W. Leavitt, Jr., announce that they have entered into co-partnership for carrying on their professional work of landscape architecture and civil engineering, the firm name being Ulrich & Leavitt. They will make a specialty of furnishing surveys, plans and estimates for developing public and private grounds, including irrigation and drainage. Mr. Ulrich has a large and varied experience, having been landscape architect and superintendent for Hotel del Monte Park, Monterey, Cal., and the public parks of Brooklyn, also for the World's Columbian Exposition at Chicago (under Messrs. Olmstead & Eliot). Besides these he has designed and laid out a number of private grounds. Mr. Leavitt has for several years been in charge of the engineering for the improvements at Essex Falls, N. J., and has also been Assistant Engineer in the East Jersey Water Company. The offices of these gentlemen are at 15 Cortlandt street, New York City.

Judge Sage, of the United States Circuit Court for the Southern District of Ohio, last month rendered a decision in the long-drawn-out suit of W. W. Dodge *et al.* vs. Post & Company *et al.* The defendants were held to infringe two claims of a patent on wooden split pulleys, No. 290,462, granted to Dodge & Phillon, which claims read as follows:

"1. A separable pulley whereof, when the meeting ends of the rim are in contact, the meeting faces of the spoke-bar and hub are slightly separated, as described, combined with clamp bolts *G*, whereby said hub is clamped upon the shaft in the manner set forth.

"3. A separable pulley whereof, when the meeting ends of the rim are in contact, the meeting faces of the spoke-bar are slightly separated, and clamp bolts *G*, combined with a separate split thimble interposed between said shaft and pulley, substantially as set forth."

The Dodge Manufacturing Company, Mishawaba, Ind., owns the patent thus sustained.

The Keystone Axle Company expects to start up a new plant for making car axles at Beaver Falls, Pa., on Jan. 1. The process is a new one, the axles being rolled instead of forged, and it is expected that the rolling process will add to the tensile strength of the material. The building, 80 by 200 feet in size, has been put up by the Pennsylvania Bridge Company. Steam will be supplied by six Brownell boilers of 1,200 horse-power. The rolls are being made by Robinson, Rae & Company, of Pittsburg, from designs furnished by J. T. Rowley, of Tyrone, Pa. The rolling process consists of first reducing blooms nine inches square to round bars 5½ inches in diameter. These are cut to the exact length of the axle end, after reheating, they pass through rolls that give them the shape of the finished axle and bring them to exact size, except at the journal and wheel seat, where one-sixteenth inch is allowed for a finish. It is said the axles will go through the shaping rolls at the rate of two per minute. The offices of the company are in the Equitable Building, Baltimore, Md. Mr. D. A. Clark is President; J. T. Rowley, Vice-President; T. R. Torrence, Secretary and Treasurer, and J. Deegan Superintendent.

Our Directory

OF OFFICIAL CHANGES IN NOVEMBER.

We note the following changes of officers since our last issue. Information relative to such changes is solicited.

Atlanta, Knoxville & Northern—This is the reorganized Marietta & North Georgia Railroad, and Mr. Joseph E. McWilliams has been appointed General Manager, with headquarters at Atlanta, Ga. Mr. H. K. McHarg has been chosen President, and Mr. Eugene C. Spaulding, Vice-President.

Central Railroad of Georgia—Mr. John M. Egan has been elected Vice-President, with headquarters at Savannah, Ga.

Chicago, Rock Island & Pacific—Mr. Wm. H. Stocks is appointed Division Master Mechanic of the East Iowa Division, with headquarters at Rock Island, Ill.

Chicago & Southeastern—Mr. W. De Sanno has been appointed Master Mechanic, vice Mr. J. W. Roberts, resigned.

Cincinnati, Lebanon & Northern—Mr. Joseph Wood has been elected President, to succeed Mr. Geo. Hafer, resigned.

Huntindon and Broad Top Mountain—William W. Noble has been appointed Purchasing Agent and Paymaster, vice S. B. Knight, resigned.

Middle Tennessee & Alabama—Mr. Gaunt Crebs has been appointed Receiver.

New England—Mr. J. T. Odell has resigned the position of Second Vice-President.

New Orleans & Western—Mr. W. W. Tomlinson has been appointed Chief Engineer, with headquarters at New Orleans, vice Mr. C. B. Deason, resigned.

Northern Pacific—Mr. Geo. C. Gorham has been elected Vice-President.

Pennsylvania Lines—Mr. Bernard Fitzpatrick, Master Mechanic at Columbus, has been appointed Master Mechanic at Fort Wayne, to succeed W. W. Atterbury. Mr. Thomas F. Butler is transferred from Wellsville, O., to Columbus, O., to succeed Mr. Fitzpatrick. Mr. Geo. P. Sweeley is transferred from Crestline, O., to Wellsville, and Mr. P. F. Smith, Jr., Assistant Master Mechanic at the Fort Wayne shops, is promoted to the position of Master Mechanic at Crestline, O.

Philadelphia & Reading—Mr. Joseph S. Hanley has been chosen Vice-President, and Wm. R. Taylor, Secretary.

Quincy, Omaha & Kansas City—Mr. O. H. Spencer has been appointed Assistant General Manager and is in charge of the purchasing of supplies.

Southwestern—Mr. B. A. Denmark has been elected President, to succeed the late Mr. Baxter.

Tabor & Northern—H. T. Woods has been elected General Manager.

Vandalia—Mr. Volney T. Malott, of Indianapolis, has been appointed Receiver.

